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The Testing of Cast Iron.

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[ABSTRACT:—Within the past decade or less radical changes have been introduced into foundry practice. Scientific methods have replaced rule-of-thumb methods, with correspondingly great advantages, in respect of economy in operation and certainty in quality of product. The present paper gives a concise summary of modern practice.—THE EDITOR.]

But few of the materials of construction have received as much attention in recent years as cast iron; and indeed it was high time that this study was taken up, for in no one branch of the great iron industry was there so much need of light.

It goes without saying that America began with this work at an early stage, got substantial results at the very start, and

with the usual practical turn all such matters take here, it was not long before the phenomena observed were classified, and the knowledge derived applied to daily practice. Thus we are to-day gradually working toward uniform methods for the production of the highest grades of material for all classes of castings.

The best results were, of course, obtained with the specialties, for here an individual investigator had at his command a wide range of experience in one particular line and with his special materials. For instance, the modern cast-iron car wheel is almost perfect in the process of making and the quality of work turned out. Chilled rolls, the malleable casting, ingot molds, stoves, pipe, gun iron, and specification castings for Government and other work; all these special lines at the present time exhibit a perfection in the state of the art considered impossible not so long ago.

The natural result of all this effort is that the consumer learns with the producer, a little slower perhaps, but nevertheless sufficiently to enable him to discriminate between the methods and results of the progressive founder, and the man who does not care, or is content to do things as his forefathers did. Hence, specifications are the order of the day. In the case of cast iron, the movement for standard specifications for the products of the industry emanated from the foundrymen, and not the buyers. This was because foundry owners were quick to note that giving a good grade of material voluntarily meant the staving off of unreasonable demands otherwise made by purchasers not fully up to date in foundry practice.

It was not long after the nature of cast iron was better understood that the American Foundrymen's Association, which freely encouraged all these investigations, requested the American Society for Testing Materials, the clearing house of the Nation's industrial life, to promulgate standard specifications for testing cast iron and finished castings. Foundrymen, metallurgists, and representative buyers alike worked on this problem with the result that to-day there have been adopted standards for the purchase and sale of foundry pig iron, cast iron pipe, locomotive cylinders, malleable castings; and there are pending specifications for the testing of cast iron in general, and cast iron car wheels.

As a side line in the testing of cast iron, the materials used in its production are also coming in for their share of attention. Thus we have just in process of organization an important committee on preparing standard specifications for the purchase and sale of foundry coke. The adoption of such a standard, which shall at the same time be fair to the coke-maker, and the foundryman, will mean a great stride forward, and one more source of constant annoyance will have been mitigated, if not altogether removed. Those who are not right in touch with actual conditions cannot realize the damage caused by high sulphur coke just when castings of special strength or softness are wanted.

Eventually we may see molding sands and facings the subject of standardization. Indeed, for those who have given these minor and yet important matters close study, the day that intelligent and effective specifications are devised to take care of them, will be a happy one.

With these general remarks we can now take up in more detail the characteristics of cast iron upon which an intelligent and correct system of testing it can be based.

The strength, appearance of the fracture, resistance to cutting tools, density, melting point, etc., of a cast iron depends upon the relative proportion of graphitic and combined carbon present, both together making up the total carbon. That is, if the total carbon is nearly all present in the graphitic or uncombined state, the iron will be soft, in fact, a mild steel with the intersticies between the crystals filled with graphite. The fracture will also be gray or almost black. If, on the other hand, the carbon present is all or nearly all combined, the iron will be white or mottled, hard, so that tools cannot touch it, and not good for the ordinary purposes cast iron is supposed to be used for. Everything else being normal, carbon in cast iron is at the same time its most important and yet its most easily influenced ingredient.

We have only to run up the silicon content of a cast iron to change an otherwise white iron to a gray one; or leaving the silicon low, to cool the metal from the liquid state very slowly, to produce the same result. Then again, if we take a high silicon iron and cast it against an iron chill plate, we prevent the separation out of the graphite, by not giving it time to do

so before the metal is solid, and the result is an iron which is at least very closely grained and light gray, if not actually white at the point of contact with the chill. The same condition of things, though in a very much smaller measure, is observed by pouring an iron exceedingly hot.

The other elements present in cast iron naturally have their effect also, and attention is called to this fact only in so far as it will explain the reason why these elements, together with the carbon, and also the relative proportion of pig iron and scrap, the method of melting, and the subsequent manipulation in the foundry; all together have given us at least twelve distinct classes of iron castings, based on the characteristics of the metal only, and some forty-three general classes of castings, the iron in each of which is a little different from that in the others.

Without going further into this, it will suffice to say that unless due regard is given the composition and the peculiarities of heat treatment as outlined above, in any system for testing cast iron, it will not be worthy of our confidence.

It will, of course, be understood that when dealing with extremes in composition of a cast iron, in the rapidity or slowness of the cooling, and the temperature of the pour, or in the combination of two or more of these points, that the phenomena observed as to strength, appearance, and general character of the resulting castings, are very strongly apparent. Where, however, the composition of the iron is normal, that of a gray one, where it is cast neither too hot nor too cold, and is let to cool down under ordinary foundry conditions, one does not notice half a dozen different varieties or iron in the same casting.

To illustrate this point by an example directly from the foundry testing room. A test bar one-half inch square and broken transversely on supports 12 feet apart, is much used by the stove trade, to get the strength and contraction measurements. This bar is claimed by its friends to be infallible for all uses except perfectly white iron. Yet it so happens that no bar is so easily affected in its arrangement of the carbon content as this one, by the greater or less dampness of the molding sand, the temperature at which the iron is poured, not to

speak of the composition of the iron itself, which makes a small bar very sensitive. A ladle full of hot iron from which a mold is poured, then let stand for a while until pretty dull. Then another mold poured for the same sized bar, will give two tests of different strengths and different contraction measures. The stove founder had better make his tests on bars which are larger in section and hence not so influenced by inequalities in foundry practice.

If test bars were made round instead of square, one very evil effect would be obviated. The chilling of the edges by quick cooling always produces in them proportionally more combined carbon than would be the case in a round section. The chilled edges are therefore harder, and at least artificial as regards the legitimate nature of the iron. In some specifications a broken square bar is turned up round for further tests. This, it will readily be seen, leaves the resulting round bar with four hard and four soft places in the surface of the cylinder. Just how a bar of this kind can truly represent the iron in the castings it would stand for, is an open question.

Suppose, then, we make a test bar round instead of square, and quite large in section. Let us say over one inch in diameter. The metal in the mold will then have time to cool normally, the dampness of the sand will not affect it so much in the first place, and if the metal has been cast unduly hot, it has a chance to lose its excessive heat before much of it has set against the surface of the mold. Chemically speaking, the silicon in the iron has a chance to get in its work, throwing out the proper amount of graphite at the moment of set, and while the skin of the casting will be finely grained, and the interior coarsely so, the structure changes uniformly from the surface inward, without the extra complication of chilled corners thrown in. The general trustworthiness of such a round large bar is certainly much greater than a little square one, which may be made to show anything you like by suitable manipulation.

Now to go one step further. If a test bar or any flat casting is molded up horizontally and cast in that position, the metal flowing into the mold through the comparatively narrow gate, will first roll along the bottom of the mold, heating up the sand there, but cooling the iron. Now, as more iron is forced in,

the cold iron is pushed upward by it, eventually touching the cold sand in the top of the mold, while the last hot metal sets on the hot sand of the bottom. The result is a considerable difference of conditions in top and bottom of the casting, and this is quickly noticed if the material is tested cope side up, or cope side down.

To avoid this trouble, the only rational method of molding would be to get the test bars standing upright, and to flow the iron in either from the top, or to let it run upward from the bottom. This latter method gives the best results, but is too expensive for ordinary foundry use. If carefully poured from the top, especially if the bottom of the mold is rounded up, so that the stream of iron falling in does not shot itself, the bars made leave nothing to be desired. We now have round bars of large diameter cast vertically, as more reliable when compared with smaller square ones cast flat.

The next step to be considered is whether the mold cannot be made so that its nature does not artifically strengthen or weaken the test bars. This is done by subjecting the ordinary green-sand article to a drying process. As all of our foundries are equipped with drying facilities for their core work, this provision for the greater accuracy of a test bar in representing the metal it is cast for can be easily carried out. A flask for test bar purposes should therefore be made of iron, so that the mold can be dried in a core oven, and cooled before casting.

Perhaps we should before going further discuss the very idea of testing cast iron as it is carried out to-day, so that the reasoning therefor may be understood. The only way to know whether a casting will stand up under the service strain it is supposed to undergo, is to put it under such conditions, and see if it will pass muster. For safety, we always put it under a test at least 25 per cent. to 50 per cent. more severe. Now we cannot test the thousands of castings that are made daily, nor are many of the castings made in such a shape that we can apply any tests which will give us the desired information. Some, however are, such as the car wheel, and here three are taken from a given lot of 103, and broken under what comes as near to service conditions as can be made possible, short of actually putting them in a train and wrecking this by excessive severity.

Again pipe may be put under bursting pressure, car couplers may be pounded by drop weights, etc., but for the great majority of castings no way can be devised to give us an inkling of what they will actually stand by a direct test.

For this reason it has come to be conventional to take bars of cast iron, of the same ladle as the castings, or at least from the same heat, at regular intervals. These bars of iron are broken either transversely, or under tensile strain, or both, and from them we learn what was the quality of the iron which went into the castings. It stands to reason that when we are put to it to judge our castings by another casting, different in shape, and tested under conditions different from what will be the case with the original work, we certainly do not want to deceive ourselves in any particular about what we are doing. The key-note of American testing practice, so far as cast iron is concerned, is, therefore, to give the iron put into the test bars the very best chance possible to exhibit its properties just as they are, neither artificially strengthened, nor weakened, by irregular foundry manipulation. If the iron thus cast shows up to be of first-class quality, the castings the tests are to stand for, will also be of good iron, and it should, in fact must be, left to the knowledge of the founder of his business, to see that the molding and pouring conditions for the castings are such that the best possible results are obtained.

The wise founder, therefore, will always open his laboratory fully to the inspector of the purchaser, it being his safest guarantee that the greatest possible care is taken to have none but the best material to start with, and none but the best practice to use it.

Some further items on the test bar question must not be forgotten. In the first place, it is important that the bars be not rumbled, or treated otherwise than simply brushing them off when taken from the sand. Your fellow-townsman, Mr. Outerbridge, was the discoverer of the remarkable strengthening effect of the rolling barrel on castings, the molecules of which are brought to their normal positions by this rattling process.

The speed of testing is also important, for a bar broken unduly quick is apt to show higher figures than one tested unduly slow.

Now, as to the pressure put on the test bars in breaking

them. The transverse test is always preferred by those who are familiar with the characteristics of cast iron, not because the tensile test is not better, but because the difficulties in getting a fair tensile test on cast iron are so great that the slightest imperfection in the machine grips, or the skin of the bar, etc., will give a side pull, which reduces the record so abnormally that an otherwise good iron will be condemned. The transverse test also dealing with figures about one-tenth as large as the tensile requirements, allows every foundryman to have his own small machine. He can, therefore, make daily tests for the purpose of checking his work, and can thus, if he wishes it, steadily improve his output in quality.

Another point that must be considered in the preparation of the test bar which is to be used under the tensile test, is the necessity of removing the skin. Every casting has the surface covered with very fine hair cracks, to a greater or less extent, accordingly as the metal is hard or soft. Now in pulling apart such a bar, rupture will take place much sooner at one of these cracks than at any sound place. As these cracks are never deep, but in the skin only, cutting off enough metal to get below will remove this danger. For this reason the broken parts of a transverse bar after the test can be turned up to remove the skin, and then pulled under tensile strain.

We have now gradually developed the ideal conditions under which any system for testing cast iron, and the preparation of test bars, should be undertaken. Perhaps we may have omitted some details inadvertantly, but it is hoped not. We must now take into account certain commercial limitations, which cannot be avoided, otherwise even the best system will not be used. First of all, any system for testing cast iron which is to be the basis of specifications must not be burdensome to the founder, while amply protective for the buyer. That would mean that the necessary molding, pouring, and finishing should be done without interfering with the making of the actual castings. The number of test bars must not be too great, and they should be cast from the first and the last of the heat, and enough between to make a given number of tons of castings represented by sufficient bars to prove them up. All these bars should be tested, and if only one bar of the two or more made in each mold passes, this should be suffi-

cient. However, one must pass out of every mold poured, otherwise the iron would be open to suspicion. As the ordinary limit of the commercial transverse testing machines in the foundry is about 5,000 lbs., this figure should not be exceeded in designing the bar. For tensile tests this is a different matter, as the bars in any case would have to go to the very best testing laboratories available. In fact, where a tensile test is demanded, the work entailed is so onerous and expensive that no founder should be expected to stand it, and hence it should be charged to the buyer. The same can be said in cases of dispute, where both buyer and seller claim to be right. On calling in an outside expert, satisfactory to both parties, the loser should always pay the bill. This is mentioned merely by the way, as it forms the substance of one clause in the Pig Iron Specifications recently adopted.

A further commercial limitation is the speed of testing. This should be as high as it can, consistent with correct results. Elaborate experiments have been made along these lines, and the conclusion arrived at is that a rate of application of the load for 30 seconds to give a deflection of 1-10 inch is about right for cast iron. As already stated further above, when tensile tests are demanded, the test pieces should be turned up from the ends of the bars broken in transverse test. This saves the casting of extra bars. Of course it is understood that the founder can cast as many extra bars as he likes for his own information, as it is at his own expense, but once he knows his own record from daily observation, he will not need to do this, except perhaps for Government work, where usually the price received allows of all kinds of precautions.

While considerable stress has been laid on the total carbon in its two divisions, one other element should come in for some notice also, as it has a far reaching effect on the strength and hardness of a casting. This is the sulphur. When this element is present in excess, we have all kinds of trouble in service. It is therefore necessary to limit the quantity allowable in castings, and this limit depends upon the thickness of the work. A heavy casting can carry more sulphur than a small one, for in the latter the hardening effect is more perceptible. While sulphur, therefore, must be made an item in all cast iron specifications, the other elements, carbon included, need not

be, as the combination of iron with silicon, carbon, manganese, phosphorus, and sulphur, as found in the varieties of cast iron, gives evidence of the amounts present by the strength of the bars under test. A specification which has the physical requirements prescribed, and also takes into account all the chemical ones, would be burdensome. On the other hand, if only chemical specifications were given, and the physical requirements left out, no account would have been taken of irregular or incorrect heat treatment in the foundry.

Another matter in which commercial considerations had to be reckoned with more than was desired from the standpoint of scientific testing, was the selection of a standard test bar. The correct diameter of a test bar for a given class of iron can be readily learnt by casting a series of round bars in dry sand ranging from half an inch upwards to about four inches in diameter. On breaking them transversely, the fracture should be noted. The small bars will be very closely grained and dense; in the case of low silicon irons they will even be white. As the diameters grow larger, the grain opens and soon a point is reached when open spots appear in the structure. The metal at a point just before this happens will be in its best and proper condition. For instance, take chilled roll iron. The small bars are all white. As they increase in size the metal becomes mottled, then gray, though finely grained. Not until a diameter of three inches is passed will the metal begin to show very slight signs of irregularity in the density. Hence a bar or test purposes should be at least three inches in diameter. But where will a testing machine be found in common use to break such bars transversely with supports 12 inches apart? Good metal of this kind will run near or over 100,000 lbs. for this test. Again with for ordinary castings the critical diameter is about 1½ inches. Yet here also the transverse strength exceeds 5,000 lbs., or the limit of the ordinary testing machine. Hence in the so-called "Arbitration Bar," adopted by the Committee which has studied this question, a bar 1¼ inches in diameter and 15 inches long has been selected, to be tested transversely on supports 12 inches apart.

In selecting this distance for the knife edges, we differ radically from German practice. Over in Europe they are inclined to adhere to the old method of taking very long bars

and bending them slowly. We used to do this here ourselves, and the day is not so long past when a five-foot bar, one inch square was treated to a 500 lbs. weight suspended at the center. If it stood up, the castings it represented passed, if not, they were rejected. One can readily imagine how slowly and carefully the foundryman lowered the weight from the crane upon the bar, and how carefully the chain was examined so that no unexpected kincks might open up at a critical time, making a weak bar snap untimely, where it would otherwise stand up all right with the proper nursing.

My own investigations on bars of various lengths and of the same cross-section have shown me very conclusively that the longer the bar, the less sensitive it is to bending and shock. As cast iron, unfortunately, is the very worst material that can be used under shock, and as no castings in ordinary service are not subject to it, a test should take this into account. With the bars very short, say on 12-inch supports, ample opportunity is given to see how the metal stands the fairly quickly applied load. If, however, the load is put on slow and the bars are very long, time is given for the molecules to adjust themselves to the changing conditions, and the result is an artificially good value.

In concluding, it might be well to run over the salient points of the standard specifications for cast iron, soon to be issued. They will show how well the arguments advanced in this discourse have been considered by the Committee above referred to.

Cupola metal is supposed always to be used unless furnace iron is specified.

Castings are divided into three classes, those below $\frac{1}{2}$-inch in thickness being called light; those between $\frac{1}{2}$-inch and 2 inches being medium, and those above, thick. The sulphur content in these classes shall not run over .08, .10, .12, for the light, medium, and thick castings. Similarly the transverse breaking strength of the arbitration bar shall be up to 2,500, 2,900, and 3,200 lbs. for these classes, while the tensile strength, if demanded, is to be up to 18,000, 21,000, 24,000 lbs. per square inch. In the case of the transverse test, the deflection shall in no case be under 1-10 inch before the bar breaks.

The sulphur determinations are to be made from these broken pieces.

The castings must be true to pattern, free from cracks, flaws, and excessive shrinkage, but otherwise in finish as specially agreed upon, for it may often happen that an extra fine finish is not wanted, and the price is made accordingly.

The inspector is to be given all possible but reasonable facilities for assuring himself that everything is all right.

Now, as to the "Arbitration Bar." Two sets of two bars shall be cast from each heat, one from the first and one from the last of the iron going into the castings made under specification. Then, if the heat exceeds twenty tons, another set of two bars are to be cast for each twenty tons or fraction over, in addition to the two sets above mentioned. If the mixture changes during the heat, another set of bars for each change. All of these bars are to be broken transversely, and one bar from each set cast must fulfil the conditions. Tensile tests, though not recommended, may be made from the broken pieces of the arbitration bars, but the cost of turning these test pieces down to 0.798 inches d., together with the screw ends for the machine, must be borne by the purchaser.

The mold, which may consist of a piece of 10-inch pipe, properly bored for venting, has another piece of pipe for a cope, which holds the pouring basin and funnel gates. The two patterns of the bar are molded in a vertical position, drawn out, and the mold closed. Then it is dried, and cooled before filling with the metal in question. The patterns are so made that the bottom is rounded, and a taper of 1-16 inch downward provided, so as to make up for the strain of pouring. Even the facing is provided for, being sand with bituminous facing 12 to 1, all molding sand being put through a No. 8 sieve before using.

The speed of testing is given at a deflection of 0.10 inch in thirty seconds.

Finally, it may be added that as we learn more of the characteristics of cast iron, we may be able to improve the methods of testing it, but it is pretty safe to say that in this country, at least, the producer of the castings will be the one who, by his ceaseless struggle for advancement in product, attains this desired end.

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DISCUSSION.

MR. G. H. CLAMER:—The placement of test bars, and the casting of same under the proper conditions to actually represent the casting to be tested, is of vital importance. Not only does this apply to cast iron, but also to bronzes and all alloys subject to segregation. Some of the specifications in this respect are sadly deficient, because of the fact that no stipulation is made as to the manner of attaching test bars, etc. I have in mind more particularly the Government specifications, which read: "The bar to be of certain dimensions and that it be attached to the casting it is to represent." It is entirely at the discretion of the manufacturer where this bar is to be placed, and those who have become familiar with the methods of obtaining the best results invariably place the bar at the bottom, and attach the same longitudinally to the casting. A bar placed in this position represents the skin, the densest and strongest part of the solidified alloy. A test bar taken from the center of the same casting would not show within 50 per cent. to 75 per cent. of the strength of such a bar. Then again, should the bar be attached to the casting perpendicularly at precisely the same place as the longitudinal bar, it will exhibit greatly diminished strength. Such a bar acts as an individual casting simply with a large gate, and if the bar is of sufficient cross-section, a segregated center portion will manifest itself, which causes its weakness. A bar attached longitudinally is devoid of this, whereas on the other hand, a bar cut from the center of the casting is cut from the segregated portion of the same, which portion is greater the greater the thickness of the casting. In a general way, I believe this is also true of cast iron, and as has been shown by Prof. A. E. Outerbridge, one of our fellow members, by tests he made some years ago. Prof. Outerbridge cast a cube of cast iron 12 inches in diameter, and cut the same into 144 one-inch square bars, the bars on the outside of the casting being very materially stronger than those in the center. The bars from the center also exhibiting an open and segregated fracture.

It has been stated by eminent authority, the only way to get a test bar to properly represent the casting, is to make a test bar the full thickness of the heaviest part of the casting.

There is a great deal of truth in this, but as this is of course impractical in all but small work, the next best thing to do is to have a standard practice. The Committee of Cast Iron of the American Association for Testing Materials, of which Dr. Moldenke is a very active member, have adopted for this reason certain standard practice as regards the dimensions, methods of casting and testing of cast iron test bars, which has been so ably discussed by Dr. Moldenke this evening.

DR. MOLDENKE:—The question of test lugs or test bars attached to castings is very old and still stubbornly adhered to by many purchasers, notably the Government. Mr. Clamer's argument is a very able one against the practice, and he is perfectly correct in condemning it by implication. What good is a bar attached to a casting if it will give different results when placed in different positions? The founder will always place it where the best results are obtained, but what of the iron in the casting where it does not get as good a chance? For this reason the attached test bar was ignored by the Committee formulating standard specifications, and the good American idea adopted, whereby the metal is given a perfectly fair chance to exhibit its characteristics, and no more. The attention of founder and purchaser may now be directed, not to scheming how to get good results in the bars, but good foundry practice is getting out the castings sound and strong in every part.

MR. PAUL KREUZPOINTNER:—I agree with every word Dr. Moldenke has said in his valuable paper. For the reasons stated a round test bar is more uniform throughout its section than a square bar and therefore more reliable as a criterion of the quality of the iron it represents. One of the questions not yet settled in the minds of some people is, whether the test bar, is cast separate and distinct from the object which it is to represent, really shows the same qualities as the casting.

It would seem as if the test bar, when molded and cast close to the casting, we would get a more representative test bar.

In this connection I take the liberty to say that for twenty years I have opposed the tensile test of cast iron. In cast iron the elastic limit and the point of rupture are so close together, if not identical, that there is hardly any flow, and the least eccentricity in gripping arrangement will make the test piece break before flow sets in, if there is any flow, and thus we get

a fictitious value. The transverse test is a much more reliable test, giving the metal a chance to show what it is. I have had tensile test pieces of cast iron prepared in all manner of forms and have always been convinced that this method of testing cast iron is a delusion and a snare.

DR. MOLDENKE:—The fact that a separately-cast test bar rarely represents the qualities of a casting is not so much due to the pouring of the metal into separate molds, but to the difference in the section and proportion of skin to interior, between casting and test bar. As a matter of fact, the attached test bar shows just as wide differences in quality, and also for the reasons just given. Founders, therefore, are relying on the separate test bar results for their own information, whatever they are asked to do for their customer's work. The attached test bar is found practically only in Government work, and in some shops where large cylinders and marine work is cast. It will undoubtedly disappear altogether some day. I heartily agree with Mr. Kreuzpointer anent the tensile test.

Several incidental comments that have been made in the course of this discussion involve the much mooted presence of oxygen, in form of a dissolved oxide of iron, oxide of manganese, etc., in the metal in quetsion. In my opinion this is the solution of apparent contradictions met with when using good irons and getting poor results and vice versa. When it is considered that the presence of several hundreths of one per cent. of oxygen dissolved in a bath of iron will make it unfit for use where even the ordinary strengths are required, it will be readily seen that we have a lot to learn here yet. Unfortunately we have no good chemical methods for the detection of oxygen in iron. Anyone who does much work with the white irons can, however, easily see this matter for himself. Take a heavily burned heat, and shot some of it for laboratory use. On solution in the usual nitric-hydrochloric-sulphuric acid mixture, the iron will dissolve, leaving floating particles of $Fe_3 O_4$, which may be filtered off and weighed. In fact, unless this this is watched, this iron oxide may be weighed with the silica and reported as silicon, as I have often seen in check analyses which did not agree, until corrected for this point.

Now, if so little oxide of iron can make or unmake a pig

iron, there is little wonder why irons of identical composition, but made from different ores, and possibly in more or less good ways, may show different characteristics, when put into castings. It is to be hoped that our experimenting metallurgists will give this point more attention than they do.

MR. F. T. WRIGHT, referring to the test bars proposed in the "Standard Specifications" for gray-iron castings, suggested that a much more convenient and less cumbersome flask can be made from a six-inch pipe than from a ten-inch one.

DR. MOLDENKE:—The selection of the flask by the committee on standard specifications was simply for the guidance of those who wanted to go to the least expense in the matter. Hence a piece of pipe was selected. Where these tests are made regularly, it is highly advisable to have special iron flasks of proper size and shape, to give greatest ease in manipulation.

MR. ARTHUR FALKENAU:—As tensile tests of cast-iron are considered unreliable, I would like to ask Dr. Moldenke whether he has made any extensive series of experiments, comparing the transverse tests with tensile tests.

DR. MOLDENKE:—Many experiments have been made comparing the tensile with the transverse test for cast iron. I made a lot of them myself with a view of testing the current belief that multiplying the transverse test by ten gives the result of the tensile test. Where the inch-square bar is broken transversely on supports 12 inches apart, the result approximates the tensile strength of the iron pretty nearly, and for practical purposes this will do, especially when a good factor of safety is used. However, it must also be remembered that cast iron stands in no comparison with steel, so far as tests go, as the former has no homogeniety, while the latter is very much so. It is the object of the standard tests prescribed for cast iron to minimize as much as possible the effect of the lack of homogeneity of this metal, even if it does seem like hair splitting to some of us.

MR. WRIGHT inquired about certain experiments which he understood Dr. Moldenke had made with titanium in cast iron, and intimated that he and others present would be interested in hearing the results of these experiments.

MR. WM. B. READ, JR.:—On the strength of Dr. Moldenke's article on Fe·Ti as a deoxidizing agent, we made several ex-

periments, with the following results: Taking the first tap from the cupola, which was quite hot, we ran this down to a ladle placed on a pair of scales and poured into it 1200 lbs of metal. This we caught up with a second crane and ran it back up the shop to where the mould was. Before pouring we put in the Fe Ti, which came in the form of a thermite. We fastened the can containing the thermite powder on a long rod and poked it into the molten iron and stirred it vigorously. The can melted and the powder floated to the top with no appreciable result. With so much time the metal had lost its heat and was not of a sufficient temperature to start the reaction. Needless to say, we got no good results from the experiment.

On a second trial, however, we have a different tale to tell. Getting the iron *very* hot we guessed at the amount needed, and without the loss of any time we stuck the can of thermite into the ladle and stirred as before. This time just as the powder commenced to float a violent reaction set about with an almost incandescant lustre. The metal boiled violently and seemed to be raised considerably in temperature. Moreover, a great deal of slag seemed to come to the top. From this mixture we poured a second test (the first being poured from a hand ladle during the first test). The bars were poured on end, about 1½ inches in diameter. These two bars were turned down and pulled, the one before treatment showing 23,700 tensile, the one after showing 28400 tensile. Taking a test from the casting itself, which was a small boring head, we got 33,800 tensile. There was enough Ti added to give .20, but in the chemical analysis no trace of Ti could be found. The chemical analysis of the test showed Si 1.632, Comb. C .87, P .225, Sul .042, Mn .369.

Dr. Moldenke:—The experiments made with titanium were to see what action this metal had on the strength of cast iron. Different proportions from 1 to 4 per cent. were added in the shape of ferro-titanium, and tests bars cast and broken. The results all showed marked improvement in strength, and in every case the titanium had burned out of the metal, going into the slag. The reason seemed to lie in the removal of oxygen, and perhaps other gases from solution in the iron, thus leaving the crystals cleaner and more adhering. Too lit-

tle work was as yet done along this line of removal of the gases in solution and combination with iron, to say exactly what happens, and it is hoped that we may hear more of this later on.

The use of thermite has a further advantage. Thermite is a mixture of aluminum powder with oxide of titanium. The burning of the aluminum, combining with the oxygen of the titanium, releases the latter and free titanium enters the melted iron, there doing its work of purification.) This further advantage is in serving as a means of introducing other metls into iron. Thus, nickel, which has a very high melting point, is difficult to get into combination with cast iron, the melting point of which is much lower than that of steel, where nickel is easily absorbed. Thermite, this time composed of aluminum powder, and oxide of nickel, instead of oxide of titanium, is an excellent medium for the introduction of nickel into cast iron. The principal use of this grade of cast iron is for chemical pans, etc., where ordinary cast iron will not last.

THE "CRITICAL POINT."

The critical point is that temperature above which no pressure short of "infinity" can reduce any given substance from the gaseous to the liquid condition. The critical temperature of carbon dioxide is 32.5 deg. C. Below its critical temperature, pressure can reduce the particular substance from gas (or vapor) to liquid. Thus Faraday succeeded with ammonia, sulphur dioxide, etc.; but he failed with hydrogen, oxygen, nitrogen, and carbon monoxide because he worked under conditions above their respective critical temperatures.

COMPOUND GAS ENGINE.

According to the *Iron Age*, a compound gas engine has been built with two high-pressure cylinders and a single low-pressure cylinder between them. The high-pressure cylinders work on the Otto cycle, the engine receiving one impulse from them each revolution. The exhaust from the two explosions is expanded in the low-pressure cylinder, the crank of which is 180 deg. behind the high-pressure cranks. Thus, at every forward stroke the low-pressure cylinder takes the exhaust gases from one of the high-pressure cylinders. The total effect is thus to produce an impulse every half revolution. With a 12 horse-power engine 13 brake-horse-power were obtained with the low-pressure cylinder in use, and only 8.9 horse-power without it, 46.2 per cent. being thus added to the power by the use of the low-pressure cylinder and without the expenditure of any additional fuel.—*Iron and Ore Supplies.*

Mechanical and Engineering Section.

(Read by Title.)

The Mississippi: Controlling Floods, Navigation Improvements.

By H. Van Meerten, Member of the Institute.

[Continuation of discussion—Haupt—Van Meerten]

I beg to recall to the readers of this *Journal* that, in the October number of 1903, there appeared an able article from Prof. Lewis M. Haupt, bearing the title "Controlling the Floods of the Mississippi;" that in a letter which was published in the May number, 1904, I expressed my sympathy for the greater part of the measures proposed by Prof. Haupt, but strongly objected to one of them, namely, that of creating outlets. I fully agreed with him in recommending greater discharge capacity by removing bends, by stopping levee construction and heightening, but in that one point only I dissented from his propositions, namely, that of creating and maintaining outlets.

In his answer to my remarks, I perceive that he quite misunderstood me, and I endeavored to correct his views in a later communication. I afterwards tried to explain how the Netherlands' Waterstaat practically carried out their prevailing ideas, and showed how perniciously outlets had interfered with the regular regime of the lower Rhine, Meuse and Scheldt; how inundations were not prevented, and how sedimentation of several reaches was the result.

All this, however, has a somewhat polemic character; criticism without resulting in building up. It is breaking down without subsequent construction. I will now try to build up, with such materials as are at hand. I regret that I have not more complete data at my disposal. Therefore when, in the following, I propose a scheme for improving the "Father of Waters," it is with the strict reservation that I hold myself not responsible for errors eventually committed in the estimation of quantities, as my premises are not complete, and it is, therefore, not impossible that I may err. Nevertheless, I believe that I am not very far astray; but in all cases I can explain the principles of the proposed works.

Let me say at once that, according to the principles which

have guided the Danube Engineers, the Waterstaat Engineers and the Tyne and Clyde Commissioners, I should propose for the Mississippi:

1st. That it should have one continuous road-bed gradually increasing in capacity from source to mouth; its capacity being in proportion to the waters carried downward, and insuring as much as possible a current of uniform speed.

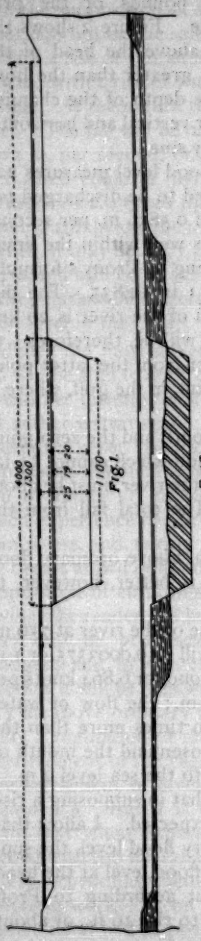
2d. That it should have a well defined summer and winter bed, both unencumbered by dykes (levees), buildings, brick-kilns, &c.; only against extraordinary floods, and exceptionally, should dykes be resorted to; ordinary winter floods must have a free, unobstructed passage into the sea.

3d. The regulating of the river, the impounding of its road-bed, where it is too broad, should be effected not by dykes, but by cribs at regular distances. The portion cut off of the roadbed will silt up, and the river creates its own roadbed. An additional advantage of this mode of operation is the land reclamation which will follow, but this is of secondary importance only.

4th. The straightening of the river-bed, preferably by crib-work, but if this should be found to work too slowly, by excavating and dredging.

According to the observations of Capt. James Eads, the discharge of water at the mouth of the South Pass was, in 1875, 1,614 cubic meters per second. According to Mr. E. L. Corthell, formerly Chief Assistant Engineer, South Pass Jetty Works, the South Pass discharged only 0.12 of the whole mass of water carried by the Mississippi. Accordingly the undivided river shoals carry 13,450 cubic meters per second. According to Prof. Haupt, the discharge in flood time exceeds 28,315 cubic meters, or about 2.25 times the mean discharge. At a distance of about 750 m. above the head of the passes, the river has a breadth of 2,450 m., with a mean depth below mean high water, or average flood-tide, of 6.876 m. The profile of discharge measures, therefore, $2{,}450 \times 6.876\text{m.} = 168{,}329.7\text{m}^2$. The mean velocity of the current should, accordingly, be almost exactly 0.8 m. per second, or rather more than 1.55 knots per hour in ordinary times, which is rather too stiff for navigation. Lowering this velocity would be advantageous, if it be sustained below and above, otherwise there will be sedimentation

and erosion where they are not wanted. Tides oscillate at the rate of 0.56 m. at the mouth, but however slight the oscillation, it must be taken into account.



These are the scant premises at my disposal. However scant, they are sufficient to explain the measures which I am about to propose.

The main roadbed of the Mississippi should consist of a summer bed with lateral berms, which, with the summer bed, constitute the winter, or flood bed. These berms should be sacred ground. Under penalty, it should be forbidden to create dykes, to build houses, brick kilns, pavilions, or anything else which may retard the current in winter time. As for ditches and culverts to drain the land in summer, there is no objection. Cultivation in the summer time at the risk of the harvest being lost by premature floods, may be allowed; but no summer quays should be built to protect the crops against inundation.

At the head of the passes the summer bed should have a breadth at the bottom of 1,100 m., at the top of 1,300 m.; the slopes are then not too steep and can be reckoned upon. The top of the bed should be above the bottom 20 m.; 1 m. below this should be ordinary flood level; the depth below flood is accordingly 19 m.; a splendid waterway for the greatest ocean steamers. The winter bed at this station should have a width of 4,000 m.

From the above point the winter bed should increase to 5,000 m. and

the summer bed to 1,500 m. at the landsend or mouth of the river. Figure 1 shows the bounds of the proposed summer and winter beds in profile. Figure 2 shows the proposed profile of the river, 750 m. above the head of the passes. The vertical scale is ten times greater than the horizontal one, to get a clearer view of the depth of the channel, which, if the same scale were retained for vertical and horizontal measures, would become microscopically small.

The available profile below average flood level measures 22,705 m^2., the 13.450 m^3. water which need to be discharged per second will flow with a mean velocity of 0.5836 m. per second, equal to 1.134 knots per hour; which is well within the limits necessary for easy navigation. According to Prony's formula, this calls for a fall of 0.000067408, or 1 in 14,835. The distance of the point chosen to the mouth of the river is 20 km. The total fall between these two points will be, therefore, 1.35 m. From Capt. Eads's data I infer that from the latter point the current still is perceptibly about 12 km. in the gulf, where it is zero.

Suppose the mean fall between the mouth and the zero point to be half of what it is above, a supposition which cannot be far from reality; flood level at the mouth of the river must be about 0.4 m. above flood level in the sea. The total fall from the point considered will be 1.75 m.

Suppose the waters to have risen 7 m. above ordinary flood level, a rise problematically large. It is better, however, to err on the side of safety.

Let us see what will then be the regime of the river at 750 m. above the head of the passes. The fall will be 0.0003375, or 1 in 2,963, velocity of current, 3.53 m. per second, or 6.864 knots per hour. The available profile 48,391 sq. m.; the flow of water 14,355 cubic m. per second, which is ten times more than the average. The fall between the point chosen and the mouth of the passes will be 6.75 m., and from this to the sea level 2 m.

The reader will infer from these data that in supposing a rise of 7 m., something impossible has been expected. I allow that if really the sea did not rise above ordinary flood level, the supposition of a rise of 7 m. above ordinary flood level at the head of the passes would be ridiculous. But according to Prof. Haupt the level of the gulf has been seen to rise 16 ft., or about

5 m. above flood level; and if such a rise is taken into account, then the supposition of a rise of 7 m. at the head of the passes is perhaps not on the safe side. Let us see whether it is or not.

With a rise of 5 m. in the Gulf, the total available head will be 3.75 m., with a rise of 7 m. above ordinary flood level at head of passes. At the mouth there will be still 1.467 m. above the sea level. The fall will be 0.000114, which is equal to a velocity of 2.022 m. per second, or 3.93 knots an hour; the discharge will be 8,220.6 cubic m. per second, or more than six times the average; or 2.9 times the discharge which Prof. Haupt relates as being still below the actual discharge met in flood time.

Well, it may actually be much more, and the proposed flood-bed would still be of sufficient capacity to discharge the floods of the "Father of Waters" against a rise of 5 m. above ordinary flood level in the Gulf.

Under the most adverse circumstances the proposed flood-bed will be able to confront a rise of 5 m. of the Gulf.

Another question will be, whether the proposed section be not rather extravagant; whether a more modest one will not answer the case. As for that I beg to say that I should not like to propose one inch less breadth of winter bed. The proportion of about 1:3 between summer and winter beds, is one which experience has proved to be a convenient one for European rivers, and, taking into consideration the great relief that the berms afford in flood time, I should not like to embark in a proposition of curtailing in this direction. But, as in the following, the reader will be aware that a gradual regulation of the river will be proposed, gradually also its regime will be changed, and in executing the works, it will become clear, whether it will be necessary to base the works upon a flood level of 7 m. above ordinary high water or somewhat lower. Especially a regulation of the river bed with cribs favors a gradual improvement of the regime of the river and leaves the facultative settlement of levels in accordance with the teachings of experience. But it is better to design the works on such a scale that when experience teaches that they have been designed with too liberal an allowance—with too great a factor of safety—curtailing them is not only quite possible, but easy, by stopping work. If, on the other side, it should prove that the winter flood-bed as projected, is too narrow, the work already

started must be removed and replaced by others. It is better to design the works on a grand style, lest no deceptions or disappointments intervene and shake public confidence.

Perhaps there will be those who contend that the proposed system involves a great waste of land. The berms represent a precious capital of arable land, which it is forbidden to protect against floods, which are systematically withdrawn from cultivation, at least during a considerable portion of the year; and when cultivated, the crop is in jeopardy of being inundated by every unexpected flood. True; but in the same way it may be told that the system of introducing factors of safety is wasteful. A screwshaft at regular work is much too heavy for its duty; much material is wasted in its construction; but let a gale disturb the surface of the ocean, let the screw race and turn with tremendous velocity, at once afterwards be deeply immersed again, striking the water with a velocity and a *vis-viva* several times greater than under ordinary circumstances. Then, I think, no one will say it is wasting material and cost to construct the shaft with extra strength; then no one will consider it folly to allow for some extra safety under ordinary circumstances. And so I will suppose that in flood time riparian occupants will feel the benefit of these berms. How much they may grumble when the river is calm, and does not show any tendency to rise; how much they may scold at the waste of land and at the tyranny of the river improvement authorities, who don't allow even the building of a summer quay to protect a valuable crop against inundation; but the great interests which are at stake, the immense benefit which the existence of the said berms afford, make their systematic maintenance peremptory, however much the people may be inclined to transgress regulations in their behalf.

I am speaking from experience. I know that in flood time everyone only thinks, and very naturally so, of his own interests, disregarding those of others and the public. By this individual policy the evil is aggravated; the less the stream is encumbered in flood time by quays, dams, buildings, dykes, the freer its roadbed, the easier the waters find their way into the sea, and the less will be the loss of valuable property.

If these berms are maintained as rigorously as the law permits, the reader may be assured that a caving in, as Figure 2

on page 250 of vol. CLVI (this Journal) shows, or a crevasse as that on Bayou Lafourche in 1903, shown in figure 4, page 254 of the same volume, will be things of the past.

When working out the proposals for improvement of the Mississippi, I was struck with the splendid materials at hand, and astonished how little profit is gleaned from them. A waterway of 1,300 m. in width and with depth of 19 m. under ordinary conditions is available, and what is realized? A channel of only 600 feet or 183 m. in width, silting up at the rate of 5 inches of 0.127 m. a year. Will the opening of the South-west Pass remedy the evil? I am sure not. After some time it will silt up, just the same as the South Pass, if the *whole* mass of the Mississippi waters is not forced to take its way through the pass, and if outlets are not closed.

In my former article, relating to the opening of the "Oude Maasje," the reader has been made aware how pernicious the influence has been of the Heerewaardensche outlets on the reach Heerewaarden-Loevestein of the river Waal, how this silted up, and how continuous dredging was necessary. Is it not logical to suppose that the silting up of the South Pass is attributable to the same causes? Is it not rational to suppose that the numerous outlets above the head of the passes divert the waters into other channels and deaden the stream in the principal one, which *inevitably* must silt up.

I now ask the reader to follow me in the details of the proposed works. Figure 3 is a sketch showing in what way I would regulate the river at 750 m. above the head of the passes. The profile of the river being known to me, I chose it for this purpose. The river has here a breadth of 2,450 m.; it needs to be broadened into a winter bed of 4,000 m. and narrowed into a summer bed of 1,300 m. I have no information at hand about the shores of the river, but am rather confident that they are either flat or very gently sloping. Cribs of a length of 575 m. at both shores, constructed of fascines, or mattress-work, should be sunk to impound the summer bed. Layer after layer should be sunk, the crib gradually heightened to flood level, and the scouring of the river bed will gradually go on until at length the desired depth has been attained. The river will silt up between the cribs and create its own shore; that is to say, its summer shore. The lengthening of the cribs into the inside

and heightening them to above inundation level, will allow the rived to create its own winter shore. At the risk of becoming tedious, I once more repeat that the thus-created summer shore and winter bed must not be interfered with by constructions; dykes, dams, walls, houses, pavilions, brick kilns, &c., should not be allowed to be erected here. Cultivation of cereals should be allowed, when they can be harvested within a six-month, but no cultivation of trees, hedges or plantations should be permitted; ditching, however, should not be for-

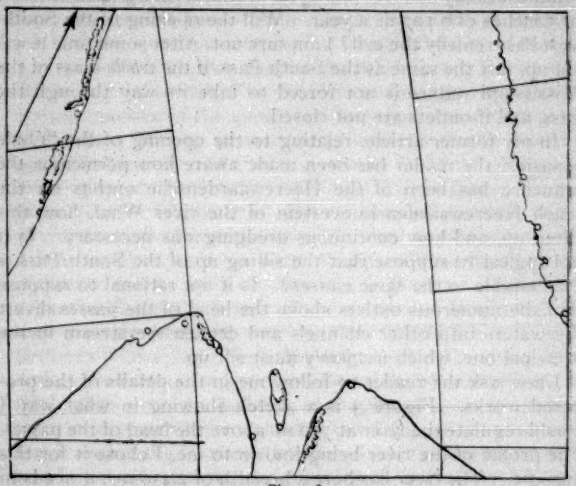


Figure 3.

bidden. The river's winter bed should remain a passage as free as possible for expected and unexpected floods.

What is beyond flood bed should be beyond the control of the River Regulation Board; but within, this Board should have supreme power. No other authority should be tolerated; its power should be dictatorial.

In figure 4 are sketched the proposed roadbeds in summer and in winter time, from Quarantine, above Forts St. Philip and Jackson to the mouth. By a series of cribs at a mutual distance of about 1 km., the river is supposed to create its own

shores. The cribs are shown in their full ends, and probably along this reach they would require to be executed so; but in the upper reaches, probably they will not need to be laid out in their full length; on the contrary, excavation must be resorted to, to create the summer bed. Where the banks are high and cave, as shown by Prof. Haupt's figure 2 above referred to, the berms will protect the lands beyond the river bed. The more I consider Prof. Haupt's figure 5, representing the lower Yazoo and upper Tensas Levee districts, the greater is my sur-

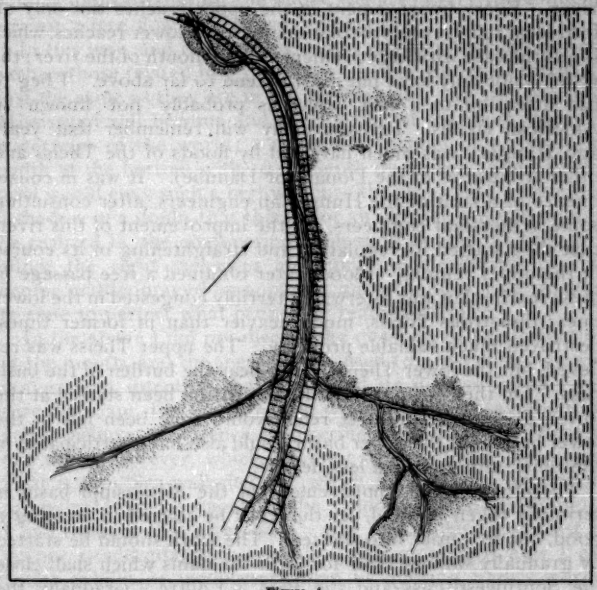


Figure 4.

prise that it should be possible to so neglect a river as is here shown to be the case. A river so neglected must inevitably cause floods and inundations. A bed so tortuous cannot be an outlet for flood water; with such a bed floods are invited. I am the more struck with the configuration of the river in this

reach, as its general direction is straight, or almost straight, and its capricious meanderings are wound up, so to say, along this line.

I now beg the reader's attention for the succession in which the work should be carried into existence. Let us start from the principle that every particle of water excepting those which are lost by evaporation, must pass the mouth of the river. Every improvement in the upper reaches can only afford local relief, even provoke calamities in lower reaches, which is not the case with improvements in the mouth of the river; the relief is not only local but must extend to far above. I beg to call attention to a fact, which is probably not known in American circles. Perhaps many will remember that years ago Hungary was much harassed by floods of the Theiss and other tributaries of the Donau (or Danube). It was in consequence of a fault of the Hungarian engineers, after consulting some Waterstaat engineers, for the improvement of this river, that they started its regulation and straightening of its course in the upper regions. Flood water obtained a free passage in these reaches but was afterwards terribly congested in the lower ones; disastrous floods, much heavier than in former times, destroyed much valuable property. The upper Theiss was relieved, but the lower Theiss had to bear the burden of the business. On the contrary, had the regulation been started at the lower Theiss, the greatest relief would have been felt in the lower basin, but the upper basin would also have participated in the relief, although in a less degree.

Therefore, if the improvement of the Mississippi basin is seriously taken in hand, let the work be started in creating a good, roomy outlet into the sea. The work should be started by gradually sinking layer for layer the dams which shall close the Southwest Pass and the Pass á Loutre. Gradually the waters will be diverted from these passes into the South Pass. Gradually the lateral passes will silt up, and the central or South Pass will scour into a wide, deep channel. When these dams are in progress the sinking of the cribs above and below should be started; when these are in progress the following cribs should be started in turn. The Jump and Cubit crevasse

should also gradually be closed. The inevitable scouring of the lower reaches will assist the works at the mouth by the greater capacity of water, which will widen the South Pass. Gradually the work should be started higher up; the bends straightened; the summer and winter beds delineated by the cribs; gradually the river will create its own roadbed. When a tributary is met, the works should go on upon the main river as well as upon the tributary. Dykes, or levees, which stand in the way should inexorably be removed; the wasted land be expropriated for the public welfare; every impediment against a free flow of the river removed.

In this way, and only in this way, I am sure that calamities, such as those related by Prof. Haupt, will be things of the past, just the same as they are in the Netherlands. In this way the Mississippi will become and remain one of the most splendid waterways of the world; a navigable channel of 1,100 m. in width at the bottom with 19 m. depth of water. Even Liverpool would envy such a highway into the sea. And I have not a shadow of a doubt that this is not an illusion, but can readily be realized by the engineering profession as soon as they will adopt the right measures and continue steadfastly in this course undiscouraged by apparent minor failures, and trusting to time to perfect what cannot be realized at once.

In the above I did not discuss the question of bar formation at the mouth, and the means to be used to prevent it. It was not without intention that I avoided its discussion, as I am sure that Capt. Eads said the last word there is to say about it; and I believe experience has verified his theory. There is one thing, however, which I cannot leave without discussion. That is the "Sea-wall theory," which Prof. Haupt once more promulgates in his paper on the "Floods of the Mississippi." I had thought that after Eads's able expostulation against it, no one would advert to it again. I do not know how I can better exhibit its incongruity than by quoting Eads's words:

"It is a popular fallacy to imagine that the Gulf presents a barrier to the onward flow of the stream at the mouth of the pass. On reflection it must seem reasonable that a river should flow with less friction between walls of water than between walls of earth. At the bar, the river has its banks of earth no longer, but it still flows between banks of salt water, and over a

bottom of brine instead of mud. It has no longer a descent of a few inches to the mile, (In this I disagree with the writer.—v. M.) however, and hence must maintain its current in the Gulf simply by momentum. Friction on its sides and bottom finally brings it to rest; but while its momentum lasts, the widening out into the sea and the final obliteration of the river will proceed very gradually."

With one exception only, which is immaterial to the case, I fully agree with this celebrated engineer's opinion. There is and there must be a fall, a slight one, it is true, but there must be some fall; as long as there is a current there is a fall. If Capt. Eads's theory were true, there should be a sudden fall of velocity in the current just when the water passes the limits of the river. As ahead of them the particles of water move by momentum and fall together and exactly below only by momentum, there should also be a sudden change from fall to no fall, from an inclined surface to a horizontal one. Neither of these propositions is the case. In reality the level of the water, as it emerges from the river channel into the sea, is somewhat above the sea level, and this difference in level gradually dies out and becomes zero where the velocity reaches zero. The difference, though imperceptible in ordinary times, I have often observed in flood time.

I beg to refer further to the theory of the "Surfaces de niveau," but as the matter is irrelevant to the question, it is unnecessary to spend more time upon it. I am sure it was a slip of the pen of the eminent engineer, and pass it over. I can only say that I not only fully endorse his theory, but that I have had occasion, not once but a hundred times, to observe the facts corroborating his theory. Especially in flood time, when the rivers carry a brown-colored sediment, the current is distinctly marked far into the sea; a sharp boundary of river and sea water is so perceptible as not to be mistaken. I have so often passed this boundary, either for business or for pleasure, that I cannot fully confirm the truth of the Captain's words. Let me add that those who adhere to the sea-wall theory confound the case of the starting of the stream into the sea and the case of the permanent condition. When there is a permanent flow, such a wall does not exist and cannot exist. When there is acceleration of current the sea will act as a movable barrier

at the stage where the velocity is zero. This point must be advanced further into sea, and as long as the acceleration lasts, the fall between the land's end and the zero point will increase till the flow has become permanent; it will decrease as soon as the rush of water from above diminishes; then the sea water will force the zero point again inward.

In general, therefore, in ordinary times, when the current is permanent, or when the river is gradually rising or falling, obstruction by a sea wall does not exist. But the question changes its aspect with such cases as Prof. Haupt mentions, as for instance, when in 1860, the river near New Orleans rose 1.40 m. within two hours. In such cases the sea wall must act as a retarder; water not in motion must be put into motion, and this can only be done by an increase of the head of water. I beg, however, to refer to what I have already urged: That the works should be planned with a great margin of safety, determined by consideration of observed facts, and their construction should not be discouraged when the results are not directly those which are expected.

In 1876, the following sums were voted for levees:

Louisiana	$1,800,000
Arkansas	1,250,000
Mississippi	447,000
Missouri	500,000
Tennessee	100,000
Illinois	75,000
Total	$4,172,000

To control the floods of the Mississippi, a superficial study of Prof. Haupt's article I think will have convinced his readers that this great sum has been wasted, as the floods have not at all been controlled, and I cordially agree with the learned Professor, that it is high time to stop levee construction and levee heightening, as they can only afford temporary relief. The levee plan may be resorted to, and then with great caution in such cases, but the works must decidedly have a temporary character, such as that of the "Zomerkaden," (Sommerquays), as they are called in Holland. But still better is it to create a condition where there will be no occasion for them; and such a condition is aimed at in my above proposals.

In another grave point, however, I quite disagree with

Prof. Haupt and Mr. James A. Seddon, C.E., namely, that of the systematic creation of outlets. I will not need, however, to expand on this point. I have shown how perniciously they have operated in the Netherlands; I have pointed out that the laming of the South Pass is to be attributed to the curtailing the mass of water which takes its way through it, and therefore insist as strongly as the lessons of theory and practice can insist on the need of creating a river of sufficient capacity to carry its own waters. That is, in my opinion, the rational, and the only rational method to improve a river; it is operating in grand style; it leaves to the river the business of creating its own bed; there is harmony between aim and measures; when the principle is steadily adhered to, there cannot be a doubt that the aim will be attained, though it may be only after long, patient and expensive labor.

On another point I am happy once more to agree with Prof. Haupt. That of taking away of bends, which create great congestion of flood water.

In the above I have freely exposed my views, even against professional authority of the highest character, and hope only that the reader will make serious allowance for any awkwardness of language, by taking into consideration the fact that I am a stranger to his language, and have not within a quarter of a century visited any English-speaking country, and therefore cannot command the true idiom, and that he will be convinced that only my interest in the great river, and the people who have an interest in it, has inspired me with the necessary courage to embark in a discussion under such unfavorable circumstances; to set forth and maintain views contrary to those of authorities so able as the author of the article "Controlling the Floods of the Mississippi River."

Before concluding I beg to call attention to one circumstance. When arranging the works as proposed, every dollar expended will afford relief, locally and generally. The improvement is not bound to time, whether the Government shall expend one or two millions a year. Relief will follow, of course, with a more liberal allowance much sooner, but there is no fear that by progressing slowly, relief must await the com-

pletion of the works before it will ensue. No! Every layer of a crib will provoke improvement, if the above sketched program is followed.

In the above I have refrained from considering the financial question, and for cause. I have not, and cannot have, the least idea of the cost of works, when not even a general scheme can be fixed for want of plans, &c. The only plans at my disposal relate to the reach below Quarantine point, and that was sufficient merely to illustrate in a sketch my propositions. But although the proposed system is simplicity itself, I have not a shadow of a doubt that it will involve great cost, and that even with great activity a century will barely be sufficient for carrying them out. But a great river like the Mississippi is worth its nursing, and a great nation like the United States of America is worthy the task of nursing a great river in its bosom.

Buitenzorg, Java, July 8th, 1904.

A SIXTH SATELLITE OF JUPITER.

A telegram has been received at the Harvard College Observatory from Prof. W. W. Campbell, at Lick Observatory, stating that a sixth satellite of Jupiter, suspected by Perrine in December, was discovered by him January 4th, 1905. The position with respect to Jupiter from previous plates taken in January, is as follows: Position angle 269 deg., distance 45. The distance is decreasing 45 sec. daily. The apparent motion is retrograde and the magnitude 14. Derived from observations with the Crossly reflector on December 3, 8, 9, 10, and January 2, 3, 4.

CLOCK ACTUATED BY RADIUM.

A clock which will run for two thousand years has been invented by Richard Strutt, son of Lord Rayleigh. The motive power is a small piece of gold-leaf which is electrified by means of a very small quantity of radium salt. It bends away from the metal substance and keeps moving under this influence until it touches the side of the containing vessel. At the moment of contact it loses its electrical charge and then springs back and is again electrified, and the process repeated. Sir William Ramsay considers that this may be made into a very reliable time-piece at an expense of about $1000.—*Scientific American.*

DETERMINING A SHIP'S BEARING BY WIRELESS TELEGRAPHY.

A Boston inventor has devised a means for determining the bearings of navigable vessels under all conditions of weather, the object being to provide improved indicating devices for use with a ship's compass and the usual sailing-charts, whereby the bearings of known objects at a distance from the ship may be positively determined at times when owing to fog or storm the landmarks may be invisible.

The invention is based upon the scientific fact that "Hertzian-wave" impulses or signals may be conveyed over long distances without connecting-wires. This principle is utilized to determine the position of the ship with relation to known landmarks, thus rendering navigation safer and avoiding delays in the movement of vessels caused by foggy or stormy weather when the usual sight observations cannot be taken.

The apparatus, carried on the ship, is applied to or connected with the binnacle, which incloses the ship's compass; and it consists, primarily, of a receiving instrument electrically connected with an upright conductor so shielded that it can receive only the wave, impulse, or signal (coming from a transmitting station on shore or from another ship or light-ship) through a lateral opening or slot when such exposure is in proper range radially with said ship or shore station. The conductor is surrounded by a rotatable shield, cap, or tube slotted vertically to admit the wave or impulse from a given station at such time only, in its rotation, as the slot or opening is approximately between said station and the inclosed conductor. With this apparatus or its equivalent when used on shipboard a rotatable pointer is employed extending over and close to the compass, always in the same radial vertical plane as the slot or exposure, to indicate on the face of the compass the bearing of the station from which emanates the signal or impulse reaching the receiving instrument through such slot or exposure.

With this system of taking bearings each lighthouse and prominent landmark will have a distinctive name or number by which it is known and designated on sailing-charts, and each will be provided with a transmitting instrument adapted to continually repeat its name or number or to automatically transmit such impulse, wave, or signal as shall make the identity of the station certain. Then when a ship appears off the coast provided with the receiver and compass attachments, the elevated conductor receives through the slot of its rotating and intermittingly-acting shield the impluse sent seaward from the transmitting stations, and the navigator notes at once on his chart the bearing of the station as denoted on his compass-dial by the indicating pointer. From another shore-station he receives a different signal, and by the cross-bearings thus received he obtains his reckoning, showing exactly where on the chart his ship should be. A transmitting instrument on the ship will at such times be able to communicate with the shore-station, thus making its presence and its exact location known.—*Scientific American.*

STEEL CARS AND SAFE TRAVEL.

If, as the records of the Interstate Commerce Commission show, the majority of the injuries and fatalities on our railroads are due to collisions and derailments; and if, as unfortunately seems to be the case, the management of our railroads is unable to reduce the number of accidents of this kind; in other words, if derailments and collisions are, under existing conditions, an inevitable feature of modern railroading—then perhaps the best thing we can do is to render our rolling stock, and particularly our passenger cars, as collision-proof as possible.

The steel car is collision-proof.

A few years ago a certain company began to build steel freight cars; and, of course, the first of these that were sent out upon the road were not long in running into a smash-up. Here they demonstrated, at once, their ability to stand an amount of pounding, crushing, and wrenching which would reduce a wooden car to the proverbial kindling wood. After such a collision, what was left of the wooden cars was burnt on the spot; but the steel cars were unearthed from the wreckage of their older and frailer brothers; their trucks were replaced beneath them; and they were hauled off to the car shops to have the kinks taken out of them.

In a heavy collision, it is the telescoping of one car into another that kills and wounds the passengers; but steel cars cannot telescope. Even with the momentum of a heavy train behind it, the platform of the telescoping car is unable to shear its way through the vertical steel posts (angle irons, channels, or T-irons) which form the frame of the car body. Following the line of least resistance, steel cars, in such collision, will slide past each other, or be slewed around and rolled to the side of the track. In this case the injuries to the passengers will be only such as are due to their being thrown violently around, and will generally be limited to cuts and bruises. The all-steel cars of the New York Subway, and the composite cars with steel under-frames, have probably already saved more lives and limbs of the public than the operating company would care to admit. Had the collisions which have already occurred taken place between wooden cars of the old type, the casualty list would have been very much longer.

The Interstate Commerce Commission has accomplished a splendid work in enforcing automatic couplings and the application of the air brake. It may be too early yet, but the time is surely coming when the same Commission will urge or enforce upon our railroads the use of steel cars. For obvious reasons such a great and expensive change could only be brought about gradually; but it will surely come, probably by the voluntary act of the railroads, and as the result of a growing appreciation of the safety and ultimate economy of this durable form of construction.—*Scientific American.*

India, which at one time produced all the diamonds in the world, now produces less in an entire year than are recovered at the De Beers mines, in the Transvaal, in one hour. The present garnet production of India has four times the value of its diamond crop.

PURE NICKEL FOR COINAGE.

Mr. Albert Ladd Colby, a well-known metallurgical expert, recently published an interesting communication on the use of pure metallic nickel for coinage, which, among other useful suggestions, contained the following:

"The advantages of using pure metallic nickel for coins, instead of alloys of copper and nickel, such, for instance, as are now used in coining the United States 5-cent piece, known as our 'nickel,' may be briefly summarized as follows:

"1. Greater resistance of the nickel coin to wear, so that the imprint lasts much longer than the alloy coins.

"2. Maintenance of their bright, attractive color and appearance, in comparison with the objectionable change of color occurring in time in alloy coins containing much copper.

"3. Increased scrap value of the pure nickel coins when finally taken out of circulation over the scrap value of an alloy coin.

"4. Extreme difficulty in counterfeiting, as the more powerful presses and machinery necessary to make a nickel coin than required for an alloy coin render secrecy in counterfeiting pure nickel coins practically impossible.

"5. To the above may be added the fact that if alloy counterfeiting was attempted on account of the advantages of lighter presses, the counterfeit coin could be at once detected from the pure nickel coin from the fact that it is not attracted by a magnet, as is the case with pure nickel."—*Eng. and Mining Journal.*

HARDWOOD SUPPLIES IN THE UNITED STATES.

The greatest area of hardwood forest and the largest supply of hardwoods in the United States are in the region comprising the Southern Appalachian Mountains and the country lying between them and the Mississippi River. For the last two or three years the Bureau of Forestry has been carefully studying this region, which is rich in commercial species, especially yellow poplar, white, red, black, and chestnut oak, chestnut, white pine and hemlock. The field study covered more than four hundred counties, and included all of Tennessee, Kentucky and West Virginia, the extreme western portion of Maryland, the western portion of Virginia, and the two Carolinas, and the northern parts of Georgia and Alabama. For market value and amount of standing timber yellow poplar and white oak are the two most important trees of the region. Poplar attains magnificent size in the coves of the mountain districts and in the rich river valleys of Tennessee and Kentucky. White oak reaches its best development in the river valleys of Tennessee and Kentucky. It is present in very much greater numbers than poplar over the region as a whole, and occasionally forms over 50 per cent. of the stand. Hemlock occurs over a small portion of the region, and white pine over a still smaller part; both confine themselves to the mountainous sections. Chestnut is very abundant.—*N. Y. Evening Post.*

CHEMICAL SECTION

Stated Meeting, held Thursday, February 16, 1905.

The Determination of Sulphur in Iron Ores.

By J. Howard Graham,

Department of Chemistry, Central High School, Philadelphia.

[The purpose of this paper is to determine the influences of ammonium chloride, hydrochloric acid and ferric chloride in solution, on the precipitation of barium sulphate. Is the latter oluble in ferric and aluminum chlorides to the extent that Williams mentions?—The Editor.]

The work presented in the following was not done with a view of publishing a paper, but purely to test statements made by Williams[1] in regards to the enormous loss of SO_3, due to the solubility of barium sulphate in ferric chloride solution, when estimating the sulphuric acid in soils. If he got such low results when determining the sulphur in the presence of small quantities of iron, what losses must be entailed where large amounts of iron are present, such as is the case with iron ores? It was believed that Williams had given due consideration to work done previous to the publishing of his paper, and since ready access to literature on the subject was not the privilege of the present writer, an experimental investigation was started. The data obtained as a result were quite conclusive and satisfactory, so much so, that it was thought worth while publishing them for the benefit of any engaged in work of a similar character.

In estimating the percentage of sulphur trioxide in soils by acidifying and boiling with hydrochloric acid, filtering, precipitating with barium chloride, letting stand a "few hours," and then filtering off the barium sulphate, Williams found that the mean of several results obtained by this method was 0.022 per cent. lower that results obtained by precipitating the sulphur in solution from which all the aluminum and iron had been removed by ammonia. He terms the former the "official"

[1] Amer. Chemical Jour., XXIV, 658.

method and the latter the "modified" method. He concludes his paper by stating, "The results point very clearly to the fact that where sulphuric acid is precipitated in the presence of iron and alumina, some of the barium sulphate is dissolved by either the ferric chloride or the aluminum chloride, or both, and that it can only be determined accurately in soil solutions from which these two bases have been eliminated. If the results by the modified method are correct, and it cannot be seen why they are not, then the official method lacks over 35 per cent. of getting out all the sulphur trioxide. In an experiment to test the solubility of barium sulphate in ferric chloride, it was found that when a solution was taken containing 0.110398 gram ferric chloride and 0.001288 gram of sulphuric acid that 17 per cent. of the sulphur trioxide was dissolved, results being obtained in closely agreeing duplicates."

It could not be credited by the writer that such losses of barium sulphate could obtain in careful work and he believed, before his investigation was begun, that the losses were not due so much to the presence of iron and of aluminum chlorides, but to the excessive use of hydrochloric acid. Then again, by experiment he found that where a moderate quantity of hydrochloric acid even was used, it required more than a "few hours" for the barium sulphate to be completely precipitated. Both the "official" and the "modified" methods had been employed in his laboratory, and no great discrepancies like those indicated by Williams had resulted.

Reviewing the literature on the subject, it is found that extended studies have been made of the "precipitation by barium chloride" method for the determination of sulphuric acid, and of the behavior of barium sulphate when precipitated in the presence of various solutes. It is the purpose of the writer just to make reference to the work done along these lines,[2] and in view of recent investigations, to call attention to the researches of Kuster and Thiel,[3] of Richards and Parker,[4] and of

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[2]Chem. News, XXI, 196; XXIV, 61, 140; XXVII, 13; LX, 19; LXVII, 247; LXX, 181, 212; LXXI, 132; LXXIII, 276.
Jour. Soc. Chem. Ind., 1887, II, 369; 1890, 25.
Zeit. f. Anal. Chem., XIX (1880), 57, 419-431; XXXIII (1894), 208; XXXVIII (1899), 209.
[3]Zeit. f. Anorg. Chem., XIX (1898), 97-103.
[4]Amer. Acad. Sci., XXXI (1896), 67.

Richards[5] himself. None of these investigations just cited, with the exception of that of Fresenius,[6] were carried out along the same lines with the work done in this laboratory, and our results are not of the same character; but they do corroborate statements made by these investigators in the following manner:

(*a*). Barium sulphate is soluble in hydrochloric acid and the proportion in which it is soluble depends upon the amount of hydrochloric present.

(*b*). It is apparently soluble also in very acid ferric chloride solutions.

(*c*). The greater the quantity of hydrochloric present, the longer the time necessary for the precipitation of the barium sulphate.

(*d*). Iron is always precipitated with the barium sulphate, but that this along with some possibly occluded barium chloride,[7] almost balances the amount of barium sulphate soluble in the solution acid with hydrochloric acid.

(*e*). When the iron is precipitated by ammonia, some sulphuric acid remains with the ferric hydroxide.[8]

(*f*). The ignition of the barium sulphate and filter paper together need not be attended by reduction to barium sulphide if done properly.[7]

The present paper presents a resumé of work carried out to ascertain, if possible, the exact influence of ammonium and ferric chlorides and of hydrochloric acid upon the precipitation of barium sulphate while working with iron ore solutions. Fresenius,[9] in a research of similar character, found that in the nascent state, barium sulphate was soluble about as follows:

1 part of barium sulphate in 100,000 parts pure water.
1 " " " " 400,000 " water when barium chloride or sulphuric acid is present.
1 part of barium sulphate in 10,000 parts of 8 per cent. solution of ammonium chloride.
1 part of barium sulphate in 22,000 parts of 2.3 per cent. solution of ammonium chloride.

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[5]Idem. XXXV, 378.
[6]Zeit. f. Anal. Chem., XXXV (1896), 170.
[7]Amer. Acad. Sci., XXXI (1896), 67.
[8]Gladding, Chem. News, LXX, 181.
Lunge, Zeit. Anal. Chem., XIX, 419-431.
[9]Zeit. f. Anal. Chem., XXXV (1896), 170.

1 part of barium sulphate in 22,000 parts of 2.3 per cent. solution of sodium chloride.
1 part of barium sulphate in 7,300 parts of 8 per cent. nitric acid.
1 part of barium sulphate in 7,300 parts of 8 per cent. hydrochloric acid.

Also that in all cases, the presence of barium chloride or sulphuric acid lessens to a great extent the solubility of the barium sulphate.

While Williams confined his attention not to known solutions of sulphuric acid, but to solutions of various samples of soils, it seemed preferable to use a solution of sulphuric acid of known strength and to determine accurately in it, the per cent. of sulphur precipitating in very slightly acid solutions; to check this standardization by neutralizing with ammonia and weighing residue of ammonium sulphate; then to make determinations in the presence of different quantities of ammonium chloride, of hydrochloric acid and of ferric chloride, and subsequently to make determinations of sulphur in iron ores by the "official" and by the "modified" methods, in the former, precipitating the sulphuric acid in the presence of iron and of aluminium chlorides and in the latter, first removing these constituents by ammonia.

SOLUTIONS.

Distilled Water.—Portions of 150 cc. of the same distilled water were used throughout the work; 560 cc. concentrated and examined for sulphur gave 0.5 milligram of barium sulphate, equivalent to about 0.07 milligram of sulphur. The trace was considered negligible.

Sulphuric Acid.—THE STANDARD SULPHURIC ACID SOLUTION was made of such strength that each 25 cc., representing one gram of ore, would contain approximately 0.1 per cent. of sulphur. It was prepared by diluting 0.264 cc. of sulphuric acid, specific gravity 1.86 with four litres of distilled water.

Hydrochloric Acid.—Acid of specific gravity 1.2 was employed. Ten cc. of this, diluted to 150 cc., and treated with barium chloride, gave no precipitate. However, 100 cc., evaporated almost to dryness in a platinum dish, diluted and treated as before with barium chloride, gave 0.6 milligram of barium sulphate, equivalent to 0.08 milligram of sulphur.

Dilute hydrochloric acid (1:100) was used as wash water.

Ammonium Chloride.—The "pure" salt used in the analyses was found to contain a trace of sulphur. From ten grams was obtained barium sulphate equivalent to 0.1 milligram of sulphur. In making the solution of 120 grams of the salt in 1200 cc. of water, enough barium chloride was added to entirely precipitate the sulphur, and the solution was permitted to stand a long time and then filtered.

Ferric Chloride.—This solution was made by dissolving 62.4 grams of crystallized Fe_2Cl_6+aqua, in 500 cc. of water, acidulating with 10 cc. of hydrochloric acid, filtering several times and finally diluting to 1000 cc. Fifty cc. were found to contain 0.6028 gram of iron, representing 60.28 per cent. of iron in one gram of ore, the quantity always taken in the routine work for the determinations of sulphur. Two portions of 500 cc. each were examined for sulphur, and the mean of the results in barium sulphate, was equivalent to 0.06 milligram of sulphur.

METHOD AND PRECAUTIONS.

The volume of the precipitating medium was maintained as near 150 cc. as possible. The sulphuric acid and barium chloride solutions were always boiled before adding the latter to the former, and after the addition, the solution was boiled for five minutes and set aside for eighteen hours.

Jena beakers of 400 cc. capacity were used, the high transparency of the glass being a desirable factor in searching all filtrates for traces of barium sulphate. The solutions were repeatedly filtered until clear. At times traces of the precipitate persisted in suspension, but in no case could these have been collected and weighed.

All the barium sulphate precipitates were washed in the filter five times with dilute hydrochloric acid, and afterwards three times with distilled water. All subsequent washings gave negative tests for chlorides.

Great care was taken to prevent reduction to sulphide when igniting the residues of barium sulphate with the filter paper, and at no time upon testing was any trace of sulphide found. The paper was dried, charred very gradually with a small flame, and then the temperature was raised just enough to make the mass glow and burn till no carbon remained, when a blast lamp

flame was directed upon it, and the barium sulphate ignited very strongly.

EXPERIMENTAL PART

I.

STANDARDIZATION OF THE SULPHURIC ACID SOLUTION.

(a). Precipitation with Barium Chloride.—In each of the following analyses, the volume of the solution, with the exception of the first three, was 150 cc., and the acidity, five drops of hydrochloric acid.

RESULTS.

H_2SO_4 Solution No. cc. taken	$BaSO_4$ Found Grams	Sulphur Equivalent Per cent.	Mean of Three Determinations
25	0.0065	0.0893	
25	0.0069	0.0948	0.0921
25	0.0067	0.0921	
50	0.0137	0.0941	
50	0.0139	0.0955	0.0953
50	0.0140	0.0962	
75	0.0209	0.0957	0.0955
75	0.0208	0.0953	
100	0.0279	0.0959	
100	0.0282	0.0969	0.0959
100	0.0276	0.0949	
125	0.0348	0.0957	
125	0.0351	0.0965	0.0960
125	0.0349	0.0959	

All the barium sulphate residues were white. The filtrates from the first three determinations had to be refiltered five times, and the number of necessary refiltrations decreased until the filtrates from the last three came through clear the first time. It appears that the more sulphuric acid there is in solution, the better the barium sulphate filters, and the less tendency it has to cling to the bottom of the beaker. The above differences in per cent. might be due to the small quantities of barium sulphate, which, in spite of the numerous filtrations, escaped in the wash water.

(b). Weighing as Ammonium Sulphate.—To portions of the sulphuric acid solution were added 10 cc. of ammonia, specific gravity 0.9, and the resulting solution was evaporated just to dryness in a platinum dish, on a water-bath within a hood free

from dust and fumes. The weight of the ammonium sulphate, multiplied by the factor 0.24255, gave the weight of sulphur.

RESULTS.

H_2SO_4 Solution No. cc. taken	$(NH_4)_2SO_4$ Found Gram.	Sulphur Equivalent Weight Gram.	Sulphur Per cent.
50	0.0092	0.002231	0.1110
50	0.0092	0.002231	0.1110
75	0.0140	0.003395	0.1131
75	0.0141	0.003419	0.1139
75	0.0140	0.003395	0.1131
100	0.0186	0.004511	0.1128
100	0.0184	0.004502	0.1125
			Mean 0.1125

A correction to this "mean" had to be made for the amount of residue in the distilled water plus ammonia.

This was estimated approximately, by evaporating to dryness 100 cc. of distilled water plus 10 cc. of ammonia. Since all the percentages are based on the fact that 25 cc. represent one gram of material, then the difference between the above "mean" and the one found below, will give a true mean percentage of sulphur in the sulphuric acid solution by this method.

RESULTS.

Distilled Water No. cc. taken	$(NH_4)_2SO_4$ So-called Gram.	Sulphur So-called Gram.	Sulphur So-called Per cent.
100	0.0023	0.05578	0.0130
100	0.0026	0.06306	0.0157
100	0.0025	0.06063	0.0151
		Correction and the mean	0.0149

Estimated "mean" per cent. of sulphur in sulphuric acid solution= 0.1125
Correction= 0.0149

True "mean" per cent. of sulphur in sulphuric acid solution= 0.0976

II.

SULPHUR ESTIMATIONS USING STANDARD SULPHURIC ACID.

(a). Precipitating Medium Contains Ammonium Chloride.—The sulphuric acid was precipitated by barium chloride in the presence of 15, 10 and 5 grams of ammonium chloride (percentages

approximating 10, 6 $\frac{2}{3}$ and 3 $\frac{1}{3}$) with the addition of five drops of hydrochloric acid.

RESULTS.

H_2SO_4 Solution No. cc. taken	NH_4Cl Present. Grams.	$BaSO_4$ Found Grams.	Sulphur Per cent.
75	15	0.0211	0.0967
50	15	0.0141	0.0969
25	15	0.0070	0.0962
75	10	0.0210	0.0962
50	10	0.0137	0.0941
25	10	0.0071	0.0976
75	5	0.0207	0.0949
50	5	0.0140	0.0962
25	5	0.0071	0.0976

It would appear from the above figures that low results in percentage of sulphur cannot be attributed to the presence of ammonium chloride. If this salt has any influence at all, it promotes the precipitation by causing the barium sulphate to take a granular form, much more so, in fact, than in all other cases; and therefore to filter quickly and clear.

(b). Precipitating Medium Contains Definite Quantities of Hydrochloric Acid.—In the following estimations of sulphur, the same approximate percentages as under (a), of hydrochloric acid (specific gravity 1.2) were used.

RESULTS.

H_2SO_4 Solution No. cc. taken	H Cl Present. cc.	$BaSO_4$ Found Gram.	Sulphur Equivalent Per cent.
75	15	0.0206	0.0944
50	15	0.0127	0.0873
25	15	0.0035	0.0481
75	10	0.0207	0.0948
50	10	0.0132	0.0907
25	10	0.0051	0.0701
75	5	0.0206	0.0944
50	5	0.0130	0.0893
25	5	0.0067	0.0921

It appears from the results just obtained, that the precipitation of the barium sulphate is retarded, and the fault seems to lie with the hydrochloric acid. But it is not evident that loss of barium sulphate depends entirely upon the amount of hydrochloric acid present, for we notice that the greater the quantity of sulphuric acid present, along with the same proportions of

hydrochloric acid, the nearer the results approach to what they should be. Fresenius[10] also, found that sulphuric acid and barium chloride being present, the solubility of barium sulphate is lessened to a great extent. In the presence of larger amounts of hydrochloric acid, the barium sulphate filtered clear and quickly, which was not the case where smaller quantities were present, the precipitate, besides, clinging very firmly to the bottom of the beaker.

Observing that hydrochloric acid had such a solvent effect upon the precipitate, the question was raised as to whether the results in the first standardization of the sulphuric acid (a) might not have been low, since as much as five drops of hydrochloric acid had been used. To make sure of this, the following five analyses were made, using but one drop of acid.

RESULTS.

H_2SO_4 Solution No. cc. taken	$BaSO_4$ Found Gram.	Sulphur Equivalent Gram.	Sulphur Per Cent.
125	0.0352	0.004840	0.0968
100	0.0284	0.003905	0.0976
75	0.0213	0.002928	0.0976
50	0.0139	0.001911	0.0955
25	0.0071	0.000976	0.0976

With but a single exception, these results are higher than the highest of those in the first standardization of the sulphuric acid (a), and approach closely to the mean of those in (b). The low result in 4 is accounted for by a considerable loss of barium sulphate in the filtrate. An objection to the use of such a small quantity of hydrochloric acid is, that the barium sulphate is precipitated in a very finely divided state, making it difficult to filter.

(c). Precipitation in the Presence of Ferric Chloride.—Fifty cc. of the ferric chloride solution were used each time, and therefore 0.6028 gram of iron was present, and each 50 cc. already contained 0.5 cc. of free hydrochloric acid.

For trial tests, 75, 50 and 25 cc. portions of the sulphuric acid solution were analyzed for sulphur with 0.6028 gram of iron present in each, and 5 drops additional of hydrochloric acid. The estimations could not be carried out, because on

[10]Zeit. f. Anal. Chem., XXXV (1896), 170.

boiling a film of iron salt (?) was precipitated and clung to the bottom of the beaker. As a second attempt, to 25 cc. of the standard solution, was added 1 cc. of hydrochloric acid, and to another 25 cc. portion was added 3 cc. of acid, but upon boiling a similar scale came down in each, though in less quantity. However, with 5 cc. of acid present (that is a total of 5.5 cc.) the scale did not appear, and the following three determinations were made.

RESULTS.

H_2SO_4 Solution No. cc. taken	Iron Present Gram.	H Cl Present cc.	$BaSO_4$ Found Gram.	Sulphur Per cent.
25	0.6028	5	0.0076	0.104
50	0.6028	5	0.0142	0.097
75	0.6028	5	0.0217	0.099

All the barium sulphate residues contained few specks of iron oxide, but were not colored uniformly with it. After the three above determinations, the following five were made.

RESULTS.

H_2SO_4 taken cc.	Iron Present Gram.	H Cl Present cc.	$BaSO_4$ Found Gram.	Sulphur Per cent.
75	0.6028	10	0.0219	0.100
50	0.6028	10	0.0150	0.103
25	0.6028	10	0.0079	0.108
25	0.6028	10	0.0077	0.105
25	0.6028	10	0.0078	0.107
Mean of the foregoing eight determinations				0.103

This result must be corrected, since 50 cc. of the ferric chloride solution contained about 0.005 per cent. of sulphur. Thus corrected, it would read 0.098 per cent. instead of 0.103 per cent.

The barium sulphate filtered clear and the ignited residues were practically white. It will be noticed that in the set of three determinations, 5 cc. of hydrochloric acid were used, while in the set of 5, 10 cc. were used, and yet there was no corresponding loss of barium sulphate. From the results, it would appear that neither the ferric chloride nor the hydroloric acid, together, have the solvent action upon barium sulphate attributed to them; but again it is quite evident from the results under 2 (b), that the acid alone does affect the pre-

cipitation, some loss of barium sulphate always being incurred. And it must be remembered, that the amount of acid present in the above cases is just sufficient to prevent the precipitation of the iron scale. The exact conditions in the last series of five determinations were: 150 cc. of solution containing 0.6028 gram of iron and 10.5 cc. of hydrochloric acid. The following experiments with iron ores themselves will enlighten us still further.

III.

SULPHUR ESTIMATIONS USING IRON ORES.

Samples of one gram each of ore, were treated separately with hydrochloric acid, a small quantity of nitric acid and a few crystals of chlorate of potash, and, after oxidation and evaporation, the residues were treated with hydrochloric acid and evaporated to dryness twice. To each, 10 cc. of hydrochloric acid were then added, the chloride of iron dissolved, and the solutions diluted. One of these was treated with ammonium hydrate to remove all iron and aluminium, filtered, and the filtrate just made acid with hydrochloric acid, and the sulphuric acid precipitated with barium chloride. The other solution was filtered, diluted and precipitated with barium chloride in the presence of iron and aluminium. The first method may be called the "modified method," according to Williams, and the other the "regular," or, as he names it, the "official method."

RESULTS.

	Percentages of Sulphur in Ores	
	Modified Method	Regular Method
1	0.1471	0.1677
2	0.1485	0.1650
3	0.1210	0.1512
4	0.0880	0.0948
5	0.0687	0.0783
6	0.1512	0.1677
7	0.0866	0.1210
8	0.0742	0.0852
9	0.1058	0.1237
10	0.0962*	0.1045
11	0.1512	0.1608
12	0.0687	0.0838
13	0.1086	Lost
14	0.1306	0.1590
15	0.1801	0.2177

16	0.1375	0.1333*
17	0.1828	0.1897
18	0.1787	0.1677*
19	0.1471*	0.1691*
20	0.1663	0.1691*
21	0.0948	0.0990*
22	0.0990	0.1120
23	0.0783	0.0783
24	0.0632	0.0673*
25	0.1003	0.1045*
26	0.1320	0.1320

*Traces in washings.

In the first two estimations, the precipitated hydroxides were filtered with the aid of a filter pump; but since the residues became so dry, and therefore difficult to wash thoroughly, they were subsequently filtered in the ordinary way and afterwards washed five times with distilled water. The low results by the "modified" method, in the first fifteen estimations, could not be accounted for at first; but upon redissolving the hydrated iron and aluminium and treating with barium chloride, noticeable traces of sulphur were found. In the subsequent eleven determinations the hyrdoxides were redissolved, and the occluded sulphur obtained by precipitation was filtered along with the main portion of barium sulphate. From the results, it appears, that the sulphuric acid tends to cling firmly to the precipitated hydroxides, and in appreciable quantities. The use of too much hydrochloric acid accounts for the low result in number nineteen.

The last eleven results in column one will be seen to agree closely with those in column two, except that the per cent. of sulphur is a trifle lower where ammonium chloride and hydrochloride acid are present than is the case with ferric chloride and hydrochloric acid. Similar results were noted in the work with the standard sulphuric acid thus:—

	Per cent. Sulphur
Present, ferric chloride and hydrochloric acid	0.098
" ammonium chloride and hydrochloric acid (5 drops)	0.096
Difference	0.002

The higher results by the "regular" method cannot be due entirely to the presence of iron in the barium sulphate, for although some of the residues had specks of iron oxide in them, there were many others just as white as those obtained by the

other method. As it was intended to determine iron in the barium sulphate, all the residues by the regular method had been saved. Of these, mixed thoroughly, 0.1662 gram was fused with sodium carbonate, and the ignited oxides of iron and aluminum obtained weigned 0.0039 gram, so that on the average, in every 0.01 grain of barium sulphate, (= 0.137 per cent. of sulphur), there was but 0.00023 gram of the oxides, making a difference in the per cent. of sulphur of about 0.0003. The slightly higher results, therefore, cannot be due to iron alone, so their explanation must be sought for in another source. It might be that the ferric chloride in some way counteracts the action of the hydrochloric acid, while the ammonium chloride does not.

The foregoing results are sufficiently conclusive to show that barium sulphate is not soluble in ferric chloride, to the extent at least that Williams mentions; rather that this iron salt acts restrainingly upon the act of solution of the barium sulphate in hydrochloric acid until too large quantities of the acid are present. The hydrochloric acid may prefer to form an acid chloride of iron rather than exert its solvent effect upon the barium sulphate, or the ferric chloride may act as does barium chloride and sulphuric acid to mitigate the solubility of the barium sulphate in hydrochloric acid.

In conclusion, we would recommend the method involving the precipitation of the sulphuric acid in the presence of iron and aluminium chlorides. It is the quicker of the two methods mentioned, and fully as accurate. It demands, of course, that the analyst control the quantity of hydrochloric acid he uses, a quantity that need not exceed 10 cc. if but one gram of ore be taken, for the function of the acid is principally to keep the iron in solution. We believe that the information gained in this investigation can be applied to the determination of sulphuric acid in soils as well as in iron ores.

LABORATORY OF THE SPANISH-
AMERICAN IRON CO., DAIQUIRI, CUBA.

ELECTRIC DISSIPATION OF FOGS.

The dispelling of fogs by means of electric currents is exciting a good deal of interest among leading physicists of the world. It is possible by the use of electricity to rid the city of London or New York harbor or San Francisco harbor or any other neighborhood of the heaviest fog. The only question is the cost. It may be too great, and this is what a commission is trying to ascertain at the instance of the city of London. The report is looked forward to with much interest. Sir Oliver J. Lodge, one of the foremost of British physicists, is giving this subject profound thought, which is itself proof of the importance of the work and of the probability of the successful solution of the problem. His latest patent, just granted, provides for a comparatively simple electrical apparatus, consisting of "a combination of high potential rectifiers arranged in quadrilateral groups of four, or multiples of four in such a way that, instead of the reverse pulses of the alternating current supply being suppressed or nonexistent as at present, they are redressed to form the positive and negative discharging streams required for deposit purposes." In other words, the alternating current is used, but the pulse is all in one direction.

The property of the electric discharge of causing the coalescent deposit of matters suspended in a gaseous medium has not come into general practical use on account of the difficulties attendant on the use of the statical electrical apparatus, this class of apparatus being too delicate and easily upset for use on an extensive scale, to again quote from Sir Oliver's patent papers. There is nothing new in the knowledge of the general principle involved in all fog-dispelling apparatus. The direct current passing through the atmosphere provides, in the form of electrons, the necessary nucleus about which the particles of moisture collect until they constitute drops of rain. To dispel the London fogs, for example the apparatus would be stationed at different points about the city to project their currents through the atmosphere until the fog has precipitated as rain.

Electrical engineers agree that the cost of such operations would probably be great, measured in equipment and maintenance, as well as in horsepower required. It would mean the establishment of large electric power stations. Possibly such stations might dispose of their power to financial advantage during days when their services are not needed for ridding the city of fog. But the cost of alleviating this moisture and hindrance to business would be considerable, no matter how economically the electric plants might be managed. Yet in considering the cost, it must be with relation to the good accomplished in the health and comfort of the community, as well as to business. A London fog costs a good deal of money. So does a fog in such a harbor as New York. It holds up the routine of business, which is expensive. Thus while it might cost a great deal of money, yet compared with the financial saving by preventing the holding up of business, and with the general public benefit, the expense might be relatively small, as is frequently the case in the matter of large public expenditures.—*Scientific American Supplement.*

CALCIUM CARBIDE AS AN EXPLOSIVE.

According to M. P. S. Guédras (*Comptes Rendus, 1904*), calcium carbide is introduced into a metallic cartridge, separated by a diaphragm from the necessary water for its decomposition; the cartridge also contains an air space and a cavity having the detonator. The cartridge is introduced into the bore-hole, which is tamped with a wooden plug, and by striking a projecting rod the diaphragm is pierced. After five minutes the cartridge is exploded by firing the detonator. The rock is shattered, but not projected, and can be easily hewn with a pick. The charge of carbide is 50 grams.

GOLD FROM SEA WATER ONCE MORE.

Sir William Ramsay recently has announced that the old problem of extracting gold profitably from the sea can be successfully solved.

Newspapers of repute have given much space to explanations and interviews thereon, and even the staid *Spectator* devotes two columns to a consideration of its possible success and the effect thereof on the world's economy.

There are some ridiculous calculations based on alleged results. One critic solemnly asserts that 5,000,000,000 tons of solid gold awaits successful prospectors. The bubble has not yet been pricket, though it has been contracted in its dimensions. The weightiest authorities, speaking with gravity and becoming dignity of the exalted promoters, have expressed disbelief in the theory that it will pay to extract the gold.

The syndicate interested in the scheme is said to have employed Sir William Ramsay professionally, but seem to share with him the fear of eventual ridicule, for on a recent exposure they and he alike hastened to make statements "with a view," as they said, "of stopping possible speculative dealings by the public." At that time Sir William Ramsay wrote:

"The process is still in an experimental state. Needless to say I do not hold shares in the syndicate."

The inventor of the process by which it is hoped to make a corner in the world's gold is H. J. Snell.

We question very much whether Sir William Ramsay has stated more than the fact that sea water contains a certain percentage of gold, a proposition that no chemist will deny. Probably upon this utterance of Sir William's the London syndicate has built its extravagant claims.—*Scientific American.*

RESISTANCE OF RAILWAY TRAINS.

An author in *Zeit. des Oester. Ing. Ver.* after having reviewed the trials of M. F. Barbier on the Northern Railway of France on the resistance of trains, gives the results of other independent tests of the same kind to secure similar data regarding Austrian rolling stock, says a writer in *Machinery.* The result of these experiments has been presented in the same form as those of Mr. Barbier, and the formula derived is $R = a + bV + cV^2$, in which R is the resistance of the car in kilograms per ton of mater-

ial, V the speed in kilometers per hour, and a, b, and c constants which are then reduced to a graphic formula where the several factors are set forth.

These tests were not made by means of indicators and dynamometers, but by observing the speeds and accelerations which the vehicles attained upon different grades, a speed that amounted to from 36 to 48 miles an hour, and sometimes held this for a comparatively long time. In the matter of cars at least 323 trains were used whose weight, length and composition were varied to correspond with the condition of actual service.

The author also notes the difference between this method of testing and the dynamometer method, of which he has made no use. He also gives the principal dimensions of the vehicles used and the curves obtained, not only by himself but by Leitzmann, Wittenberg, Clark and others in former researches. Among other formulæ given are $R = 3.8 + 0.025V + 0.001V^2$ (between 24 and 48 miles an hour) for a 4-4-0 compound locomotive weighing 55.6 tons and having a six-wheeled tender weighing 36.7 tons in working order, attached; and $R = 1.6 + 0.184V + 0.00046V^2$ for four-wheeled cars weighing from 11 to 15 tons.

In conclusion, M. Sauzin summarizes the numerous influences which tend to modify the resistances of trains, such as wind, exposed areas, lubrication, temperature, etc.—*Scientific American Supplement.*

CALORIFIC POWER OF LIQUID FUELS.

In a paper recently published in the *Revue Technique*, M. L. Levi makes the following comparison between the calorific values of different fuels used in internal combustion engines:

	B. T. U. per lb.
Methylated alcohol	10,620
Methylated alcohol mixed with 50 per cent. gasoline	14,200
Crude American oil	19,630
Refined American oil	19,880

The mixture of methylated alcohol can, it is stated, be used as easily as ordinary gasoline, but unmixed with gasoline it is necessary to warm up the carbureter a little before starting, as the alcohol does not vaporize readily enough below a temperature of 68 deg. F. As an alternative, gasoline may be used at the start, the alcohol being supplied later. No trouble is found with the admission valves in using alcohol, and if at times there is a deposit of soot or tar, this arises generally from the use of a bad carbureter. A little acetic acid results on combustion, but not enough to cause damage. The carbureter should be of a type which will deal out a measured quantity of the liquid at each suction stroke. The exhaust gases are free from the unpleasant smell prevalent in the case of gasoline motors. The principal objection to the use of spirit lies in cost, which, to compete with gasoline, should be about twenty cents per gallon in place of about twice as much, as is at present the case in France. In Germany the cost of methylated alcohol is only about 18 cents per gallon, so that the alcohol motor is becoming more and more popular there.—*Horseless Age.*

THE FRANKLIN INSTITUTE

Stated Meeting, held Wednesday, January 18, 1905.

A New Form of Diffraction Grating Replica.

By Frederic E. Ives,

Member of the Institute.

[Abstract:—An improved method of making replicas of Rowland Diffraction Gratings. Casts are made from the rulings on speculum metal by covering with solution of soluble gun cotton in amylacetate and allowing same to dry, after which they are stripped off under water, placed face down on plane glass and the water dried out under pressure, leaving the lines as air spaces between film and glass. They are then sealed up under another glass with a balsam mixture, thus protecting them from injury.—The Editor.]

With a Rowland diffraction grating having 15,000 lines to the inch and a Browning Student Spectroscope, every line in the solar spectrum, that was mapped with elaborate care by Kirchhoff with an elaborate and costly prismatic spectroscope, can be clearly seen and the wave-lengths easily measured. The superior efficiency of the diffraction grating for spectrum analysis was first practically realized through the labors of Rowland in perfecting his machine for ruling such gratings at the Johns Hopkins University, and inaugurated a new era in spectroscope work.

Every great university, and many schools and colleges, are now equipped with Rowland gratings, but they are too costly to come into such general use as is desirable, and students are seldom allowed to use them for practice work, because they are so costly and so easily injured.

The desirability of a method of reproducing such gratings at a comparatively low cost has long been recognized, and a partial solution of the problem was realized by Thorpe, of Manchester, by making casts in celluloid, floating them off in water, and putting them down, face up, on plate glass. Such replicas are easily and cheaply made, and are good enough for some purposes, but the celluloid film always distorts sufficiently to mar the definition more or less, so that even the best of them define

better over some limited portion of their area than over all They give the best results only when the rays entering the spectroscope are practically parallel, as with direct sunlight without a condenser, and transmitted through a selected portion of the grating. Even then, owing to some scattering of the light, which manifests itself as a pale fringe or halo about the lines in bright-line spectra, the lines of the solar spectrum do not appear as black as with the original Rowland grating. Even if the celluloid film did not stretch, the manner of putting it down on glass would cause the inevitable slight unevenness of thickness not only by refraction to destroy the perfect parallelism of the emerging rays, but would also distort the plane of the diffracting surface, and the difference in refractive index of the celluloid and glass would produce disturbing reflections between the two surfaces of the replica. The defects introduced by any one of these sources of error may be slight, but that altogether they are of very material importance the result always shows.

I have had occasion to make considerable use of Thorpe process grating replicas, and have made them myself very successfully, but the desirability of realizing a more perfect method so impressed itself upon my mind that I have been carrying on systematic experiments for more than a year, with the result that I have worked out and reduced to successful practice a very remarkable improvement upon Thorpe's method.

This improvement is effected (1) by making the casts in a harder and less elastic material than celluloid; by (2) putting them face down upon the glass and forcing them into optical contact therewith, so that the perfect plane of the diffracting surface is preserved, and by (3) sealing them up under another plane glass, with a balsam mixture having the same refractive index as the casting material, so that the perfect parallelism of the transmitted rays is insured, and at the same time the grating is protected from injury.

There is a very small but even shrinkage of the casts, but after measuring up a large number, I found that it never amounted to more than four, or less than two in a thousand, and that by easily established conditions it would be kept very close to either of these figures. Under the conditions finally settled upon, the replicas come out uniformly, almost exactly

15,050 lines to the inch, and with so little distortion than an expert spectroscopist in one of our universities, working with a Hilger spectroscope, which utilized the entire aperture of the replica, declared that he could discover no difference in definition between it and an original quality A Rowland grating. A photograph of the E b region of the solar spectrum made with one of them in a Browning Student Spectroscope shown with good definition every b group line that appears in the Angstrom and Kirchhoff maps, and more than fifty lines between E and b.

The fact that these replicas are good enough for the most serious spectroscopic work, can be made at a comparatively low price, and may be handled freely by students in schools and colleges without risk of injury, leads me to think that the achievement is one of real importance.

THE FRITZ MEDAL AWARDED TO LORD KELVIN.

The first award of the John Fritz Medal, which was established by the professional associates and friends of John Fritz, of Bethlehem, Pa., on August 21, 1902, his eightieth birthday, to perpetuate the memory of his achievements in industrial progress, has been awarded to Lord Kelvin. This award was made by the following board selected for the purpose: From the membership of the American Society of Civil Engineers: Robert Moore, Alfred Noble, Chas Warren Hunt, Chas. Hermany. From the membership of the American Institute of Mining Engineers: E. G. Spilsbury, James Douglas, Charles Kirchhoff, E. E. Olcott. From the membership of the American Society of Mechanical Engineers: John E. Sweet, Robert W. Hunt, Samuel T. Wellman, James M. Dodge. From the membership of the American Institute of Electrical Engineers: Carl Hering, Charles P. Steinmetz, Charles F. Scott, B. J. Arnold. The medal is of gold of the value of about $100, and with it is presented a certificate of the award. The medal was awarded to Lord Kelvin for "Cable Telegraphy and other General Scientific Achievements.—*The Iron Age.*

DETERMINING MOISTURE IN STEAM.

A method of determining the moisture in steam at atmospheric pressure was described by Professor D. S. Jacobus, of Stevens Institute, in a recent paper read before the American Association for the Advancement of Science. A known weight of superheated steam at a given temperature was mingled with a known weight of saturated steam at atmospheric pressure. The steam, after the mixture, was still superheated and its temperature was

measured. Careful measurements were made to determine the radiation of the apparatus. From date thus obtained the amount of moisture in the saturated steam was determined. This method, he explained, is similar to that employed by Mr. George H. Barrus in one of the older forms of his calorimeters. The particular problem to be investigated was how much moisture would be contained in steam at atmospheric pressure after it had passed through two separators of a certain form. The tests showed that the steam at atmospheric pressure leaving the separators contained about one-tenth of one per cent. of moisture, a result which was within the probable error of the instrument, for which reason it was fair to conclude that the steam was dry.—*Eng. Record.*

MELTING POINTS.

A. L. Day and E. T. Allen have recently prepared, in the laboratory of the United States Geological Survey, apparatus for generating, regulating and measuring temperatures up to 1600 deg. C., which, according to *Electrochemical Industry* (December, 1904, II, xxi, p. 500), has proven easy of manipulation and very exact. It is in effect a reproduction of the Reichsanstalt temperature scale, the temperature being measured with thermoelements exclusively. The scale is establishd from the melting point of four metals, viz., cadmium, zinc, silver and copper. The melting point of those metals, as determined at Washington and Berlin, are as follows:

Metals	Washington.	Berlin.
Cadmium	321.7 deg. C.	321.7 deg. C.
Zinc	420.0	419.0
Silver	962.2	961.5
Copper in air	1065.3	1064.9
Copper in reducing atmosphere	1083.6	1084.1

These melting points are, therefore, well established for pyrometrical colibrations.

UTILIZATION OF BLAST FURNACE GASES.

At the conclusion of Rossi's article on the utilization of blast furnace gases for the generation of electrical energy, especially in connection with the problems of electric smelting, the author gives a tabulation of the various estimates which have been made by different authors on the energy available from the surplus of blast furnace gases over all requirements of the blast furnace. These estimates vary between 468 and 868 hp. per ton of pig iron made per hour. If all the surplus blast furnace gases in the United States should be utilized there would be available between 1,000,000 and 2,000,000 hp. The figure calculated by the author from Gayley's data in his dry blast run (with only 1,726 pounds of coke per ton of iron) is 724 hp. available per ton made per hour.—*Electrochem. and Met. Ind.*, May.

THE OSMIUM LAMPS.

The "Auer Os," as it is called, from its inventor, Herr Auer von Welsbach (who also invented the mantle of thorium and cerium), is constructed of a filament of metallic osmium. This is a rare element, the first of the heavy-platinoid group, including osmium, iridium and platinum. Osmium as a metal has had, till recently, but little use, except in such restricted ways as the osm-iridium point for gold pens. Of its chemical compounds, the only one that is fairly common is the tetroxide ("4-oxide") OsO_4 or "osmic acid," as it was popularly but inaccurately called; this is used in staining thin sections of organic tissue in microscope work. Some peculiarities of this oxide are, that it is readly formed by heating the metal, that it is volatile, and worst of all that it has occasioned bad accidents to eyesight. The vapor of this tetroxide on touching the cornea of the eye of the careless experimenter is reduced to metallic osmium, which forms an artificial but unremovable "cataract," resulting in a permanent clouding of the sight. On the whole, however, the metal peacefully reposed in the cabinet of chemical curiosities, till it was called upon to furnish a luciferous filament in competition with the ordinary incandescent carbon lamp. At 37 volts, and 1.5 watts per c.p., the filament is 280 mm. long and has a diameter of 0.087 mm.; it thus appears that a pound of osmium can furnish many thousand lamps. The difficulty of making a thin and even thread was overcome by mixing the finely-divided metal with thick paste of some sticky organic compound; this was forced through a die made of diamond or sapphire, emerging as a filament, which was then charred in the steamy reducing atmosphere. Osmium is brittle when cold, but soft when heated. The life of the lamp has frequently extended beyond 5,000 hours. The rival in metallic-filament lamps is that made of tantalum, but both are in the state of promising experimentation. Fritz Blau recently read an authoritative paper on this subject before the Elektro-Technische Verein of Berlin.—*Eng. and Mining Journal.*

THE TANTALUM LAMP.

A life test of tantalum lamps, which has now progressed about 550 hours, has given results that bear out quite fully the statements concerning the lamp made by two engineers on the staff of the Siemens & Halske Company. Two lamps with clear globes have been burning about 550 hours, and they have not fallen off in candle power as yet by 10 per cent. The efficiency is about 1.8 watts per cp. for the clear globe lamp and 2 watts for the frosted globe lamp. The filaments get beady in appearance after about 50 hours, but change very slowly subsequently. Burned in a nearly horizontal position they sag considerably during the first period of their life and then begin to tighten up again. The light has almost exactly the same hue as that of the Nernst lamp. In this test the tantalum lamps have held up better in candle power than an Edison lamp burned and tested with them for a check.—*Elec. World.*

"BEWARE OF THE UNEXPECTED; IT IS THE IMPROBABLE THAT HAPPENS."

This motto used to be printed on the wall of an old New England school of engineering. The converging of varying factors into one definite result, often malignant, sometimes benign, is illustrated in the natural history of accidents. We know of a case where a man fell into one of the large stock-bins at a huge Western smelter, and, owing to prompt action of the foreman, came through with the ore, and came through alive. All engineers of any experience can parallel this with dozens of anecdotes of accident with a fortunate sequel; but of the whole list, few could match—in novelty, at least—the experience of the workman who was recently blown unharmed through the roof of the New York-Brooklyn Subway tunnel by a compressed-air leak, up through the bottom of East River,, in a dramatic geyser of aerated mud and water, to be promptly rescued by a policeman who was at hand as though in waiting. This sounds like a tale of Jules Verne, but it is only a bit of actual commonplace; the humor of it is that it befalls not always the clairvoyant nor the theosophist, but the engineer.—*Eng. and Mining Journal.*

ELECTRIC FURNACE INVENTIONS.

F. J. Tone, of the Carborundum Company, has patented a method of heating carbon articles (brushes, electrodes, etc.), which, like the manufacture of carborundum, belongs to that class of electric resistance furnace methods in which the current is passed along a definite path (the "resistor"), thus localizing the heat. While in the corborundum furnace the charge (which is a non-conductor of electricity) is packed around the carbon resistors, this is not done in the case of carbon articles which are conductors. Mr. Tone arranges them in groups or masses without interposed insulation, and separates them from the resistor by an air space which later on is filled with gaseous products of the driving off of volatile matter. Since there is no direct contact between the resistor and the carbon articles, the heat is conveyed to the latter by convection and radiation.

D. A. Holmes, S. A. Tucker and E. Van Wagenen have patented an arc electrode consisting of zirconium carbide admixed with a suitable binding material, such as coal tar or molasses. The flame arc between two such electrodes is said to give "a light of exceptional brilliance when compared with arc lights of other kinds which are subjected to the same conditions of temperature (or voltage and current)." The zirconium carbide is prepared in an electric furnace from the mineral zircon admixed with an excess of carbon. In this connection it may be mentioned that according to reports from Germany zirconium is the metal of the filament lamp which is about to be placed on the market.

Three patents granted to F. J. Machalske refer to the treatment of phosphate rock. Rock containing tricalcium phosphate is crushed and mixed with sodium chloride and carbon and the mixture is heated in an

V.1
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electric furnace to a temperature sufficient to decompose the rock, and effect the production of phosphoric chloride and calcium and sodium carbides. The phosphoric chloride is treated with water for the production of phosphoric and hydrochloric acid. The calcium-sodium carbides may be treated with water for the production of acetylene, calcium hydroxide and sodium hydroxide. If the above electric furnace process is carried out in an atmosphere of nitrogen the carbides combine with the nitrogen to form cyanamides, which may be treated with water for the production of calcium and sodium carbonates and ammonia, or they may be mixed with sodium carbonate and smelted in an electric furnace for the production of sodium cyanide.—*Elec. World.*

TIN IN DAKOTA.

Among recent discoveries of tin ore is that at Tinton, in Lawrence county, South Dakota, near the Wyoming boundary. The cassiterite is found in a granite rock, which intrudes among mica and hornblende schists; the tin-bearing pegmatite is 245 feet thick, and of this thickness 104 feet is said to contain 0.69 per cent., or, say two-thirds of one per cent. metallic tin. An adit 400 feet long cuts this width of ore at 80 feet below the surface. Open-cuts exhibit an extension of the deposit, and have yielded the material which has been sent to a mill, 3,000 feet from the mine. The mill contains Gates crushers, roughing rolls, finishing rolls, a bucket elevator, spitzkasten, impact screens and Bartlett tables. It was intended to crush dry, but the mica in the ore rendered screening so difficult that wet methods were adopted. The concentrate obtained assayed 63 per cent. tin, and the loss in treatment was nearly 16 per cent. It is expected that total cost of operation with a large mill, would not exceed $2 per ton, but this is on the assumption that a large and continuous supply of ore is forthcoming, which remains to be proved.—*Eng. and Mining Journal.*

STRUCTURE OF STEEL.

When a solvent absorbs a solute, as common salt, there is a wide variation possible in the proportions of the two as long as the temperature is fairly high. But when the mixture freezes, one or the other of the solution-ingredients will separate as it happens to be in excess of the eutectic equilibrium. If a dilute water-solution of salt is cooled, water will separate till the limit is reached marked by 76.4 per cent. of water and 23.6 per cent. of salt. On further cooling this mixture will remain in liquid till minus 22 deg. C., when it will congeal as one physical unit, without separation of either salt or water. This is the *eutectic* of water and salt. containing 23.6 per cent. of the latter. In the case of steel, the assumed eutectic is cementite, Fe_3C. (containing about 6.7 per cent. of carbon).—*Eng. and Mining Journal.*

Correspondence.

DR. WM. H. WAHL, Secretary, The Franklin Institute.

Dear Sir:—Enclosed please find a note from Mr. William P. Bancroft, correcting certain statements made by the committee in the obituary notice of the late Mr. William Sellers, in the May *Journal*. I would ask that you give place to Mr. Bancroft's communication in the next issue of the *Journal*, or at all events make the correction that he desires.

Permit me to take advantage of this opportunity to supply one important omission in our memorial, viz.: the fact that William Sellers received the honor of election to membership in the National Academy of Science, in 1873.

Yours truly,

C. SELLERS, JR.

Philadelphia, May 17th, 1905.

COLEMAN SELLERS, JR.

Dear Friend:—In the article in the *Journal* of the Franklin Institute respecting William Sellers, and elsewhere in print since his death, I noticed the statement that his maternal grandfather, William Poole, came from England to observe a transit of Venus, and remained here. Our common ancestor, William Poole, who, it is understood, took part in an observance of the transit of Venus, was our great-grandfather, not our grandfather, and was not an Englishman, but an American.

Respectfully,

WILLIAM POOLE BANCROFT.

Wilmington, Del., 5th-mo. 5th, 1905.

Book Notices.

PUBLICATIONS RECEIVED.

Finnisches Patentgesetz (Patent Laws of Finland), from John Svanljung, Helsingfors.

A Treatise on Gear Wheels, by George B. Grant. Eighth Edition. 1899. Grant Gear Works, Boston, Philadelphia. 8 vo., pp. 103. Numerous illustrations.

Chemical Survey of the Waters of Illinois, Report for the years 1897-1902. By Arthur Wm. Palmer, Sc.D., Prof. of Chemistry, University of Illinois print. From the University.

Catalogue of Machinery and Tools. Brown & Sharpe Mfg. Co., Providence, R. I.

Mineral Resources of the United States. Calendar Year 1903. David T. Day, Chief of Division of Mining and Mineral Resources. Washington, Govt. Print, 1904. From the U. S. Geological Survey. (8 vo., pp. 1204.)

A Primer of Forestry. Part II. Practical Forestry, by Gifford Pinchot.

Bulletin No. 24, Part II. United States Department of Agriculture. Washington, Govt. 1905. 88 pages, illustrations. (12 mo.)

Project for the Panama Canal, by Lindon W. Bates, with general plans and profiles of the waterway, the regulation works and terminal harbors. 4 to., copyright, 1905.

U. S. War Department: Annual Reports for the fiscal year ending June 30, 1904. 4 vols., ill. 8 vo. Washington, Govt., 1904.

Bulletin of the University of Wisconsin, No. 102. An investigation of rotations produced by current from a single-phase alternator, by Arthur Curtis Scott. Madison, University, 1904. (162 pages, ill. 8 vo. Price, 50 cts.

Report of the Commissioner of Education for the year 1903. Vol. I. Washington, Govt. Printing Office, 1905. (1216 pages. 8 vo.)

The Secret of the Circle and the Square, by J. C. Willmon. (30 p. ill. 12 mo.) Los Angeles, Cal., Author's Edition, 1905.

Illustrated Catalogue of Files and Rasps. 1891. G. & H. Barnett Co., Philadelphia, second edition, 1905. (46 pages, illustrated. 16 mo.)

Iowa State College Engineer Experiment Station. Bulletin No. 9. Notes on steam generation with Iowa coal, by G. W. Bissell. Ames State College, 1904. (16 p., illustrated. 8 vo.)

U. S. Geological Survey. Production of coal in the United States from 1814, the rate of the earliest record, to the close of 1904. Washington, Govt. 1905. Folded sheet.

Anthracite was the coal first mined, and from 1814 to 1821 Pennsylvania was the only producer; in 1822 Virginia began mining, the two States supplying the market until 1828. Kentucky was the next State to become a competitor, and was followed in a short time by Illinois and Ohio. Pennsylvania was again the leader in the bituminous output, which began in 1840, seven other States producing small amounts. The total output of coal in 1814 was 22 tons, from one State, and the greatest yearly output, from twenty-nine Etates, was 357,356 tons in 1903. A. R.

Preliminary Report on the Operations of the Coal-Testing Plant of the United States Geological Survey, at the Louisiana Purchase Exposition, St. Louis, Mo., 1904. Edw. W. Parker, Jos. S. Holmes, Marcus B. Campbell, Committee in charge.

The work of the committee was provided for by an Act of Congress of February 18, 1904. The history of this Act is interesting as showing how futile is an expressed intention of Congress when there is anybody who wishes to change its spirit , if not its letter. The proviso to the bill was "That all testing machinery and all coal and liquids to be tested shall be contributed without charge to the Government." But once this bill was passed there was no trouble in passing "an additional $30,000." The work has been well considered, well carried out, and the results are interesting.

The authors show their familiarity with the project by taking unusual pains to collect fair samples, for, as Huxley said, the mill of mathematics will grind one out material of any degree of communition, but the value of what you get out depends upon the quality of what you put in.

If the authors actually took the pains they describe to secure average samples they deserve very great praise. Sixty-five car loads of samples, from seventeen States, were tested viz.: Alabama, Arkansas, Colorado, Illinois, Indiana, Indian Territory, Iowa, Kansas, Kentucky, Missouri, Montana, New Mexico, North Dakota, Pennsylvania (for comparison), Texas, West Virginia, Wyoming.

There were generally four tests applied, viz.: The steam test, the washing test, the cooking test, the briquetting test and the producer gas test. Pages 32 to 60 contain analyses of the coals with proximate determinations of H, C, N, O, calories, and British thermal units; to which are joined the values of the last two calculated from the ultimate analyses, assuming the combustion of H, C, and S to produce respectively 34460, 8080 and 2250 calories.

So much has been done that it is a pity the item of fuel-ratio or the ratio of fixed carbon to volatile hydro-carbons neglecting the ash was omitted. This is more necessary when comparatively unknown coals are being investigated.

"Owing to the small appropriation"—(only $60,000)—the washery plant was made as small as possible. The washing apparatus consisted of a New Century Jig and a modified Stewart Jig. The moisture was, of course, increased; the ash and sulphur reduced. In one of the coals the amount of good coal in the refuse was found to be 3.5 per cent. of the original charge, or 5.5 per cent. of the *coal* in the original charge. For gas-producer tests a Taylor pressure gas-producer, furnished by R. D. Wood, of Philadelphia, was employed. The coking tests were undertaken in a battery of three bee-hive ovens, from plans furnished by Mr. John Fulton, of Johnstown, Pa. The briquetting tests were made in an English machine (Wm. Johnson and Son, of Leeds), and in an American machine (National Compressed Fuel Co., of Chicago).

A series of tables makes the report very convenient, as it is very instructive. F.

Lecons sur l'Electricité. Professées á l'Institut electro technique Montefiiore annexé a l'Université de Liége. Par Eric Gerard, Directeur de set Institut. Tome premier, etc., avec 400 figures dans le texte. (8vo. pp. xii + 882.) Paris: Gauthiers-Villars, Editeur, 1904.

This elaborate work is devoted to an exposition of the theory of electricity and magnetism, electrical measurements and the theory and construction ofelectrical generators. It embraces the course of instruction followed in the institute named in the title, and gives an idea of the extreme thoroughness of the course of instruction pursued in the institution. W.

Elements of Glass and Glass Making. A treatise designed for the practical glass maker, comprising facts, figures, receipts and formulas for the manufacture of glass, plain and colored, including an appendix containing useful information pertaining to the subject. By Benjamin F. Biser. Chemically revised by J. A. Koch, Phar. D. (8vo, pp. 174.) Pittsburgh: Glass & Pottery Publishing Co., N. D.

The above-entitled work is announced to have been prepared by a practical glass maker, for many years an active factory manager. It has been compiled for the use of the glass manufacturer. The principal data presented in the book have been culled from the contents of the author's note-book and may accordingly be expected to represent the ripe experiences of years of practice.

The chemical side of the work has been revised by a competent specialist. W.

Die elektrochemische Reduktion der Nitroderivate organischer Verbindungen in experimenteller und thereotischer Beziehung. Von Joh. Moeller. (8vo., pp. 113.) Halle a. S. Verlag von Wilhelm Knapp, 1904. (Price, M. 4.) M. 4.)

The publisher has added to the valuable series of electro-chemical and electro-metallurgical works issued from his press, the above-named volume dealing with certain interesting problems in organic electro-chemistry, a field which has only recently begun to attract much attention. Goeppelsroeder's pioneer work in the branch of dyeing, commenced a quarter of a century ago, for many years afforded the only examples of the attempted application of electro-chemical methods to the industries, but within the past decade the progress in this department has been highly encouraging—as witness the successful commercial production, by electrical methods, of chloral, chloroform, iodoform, vanillin and various products of the coal-tar industry.

The literature of this subject is scattered and difficultly accessible, and the present work, dealing specially with the electro-chemical reduction of the nitro-derivatives of organic compounds, will be cordially welcomed by all investigators in this field. W.

Jahrbuch der Elekrochemie und angewandten physikalischen Chemie. Berichte über die Fortschritte des Jahres, 1903. Herausgegeben von Dr. Heinrich Danneel (unter Mitwirkung von mehreren gelehrten Fachmaenner.) X Jahrgang. 8vo, pp. 930. Halle a. S.: Verlag von Wilhelm Knapp. 1905. (M. 26.)

The tremendous expansion of electro-chemical science and industry in recent years could have no more convincing evidence than this massive volume of nearly 1000 pages, in which are briefly recorded the noteworthy items of scientific and technical progress in this field of activity which were made public during the year 1903.

This year-book, since its first appearance ten years ago, has, with characteristic German thoroughness, given to men of science, engineers, manufacturers and others interested in the subject an admirable "uebersicht" of the entire field—scientific and technical—of electro-chemistry, and it has become simply indispensable to all who wish to keep in touch with it.

W.

Die Galvanoplastik. Von Dr. W. Pfanhauser. (Mit 35 in den Text gedruckten Abbildungen. 8vo, pp. xi + 138.) Halle a. S.: Verlag von Wilhelm Knapp, 1904. (Price, 4 marks.)

The art of galvanoplastic reproduction is not carried on in this country to anything like the extent to which it is practiced abroad, especially in France and Germany, where the reproduction not only of coins, medallions and numberless smaller objects of artistic or historic interest is practiced on a great scale, but likewise the copying of objects which would be regarded here as of enormous size. There is, therefore, a considerable field for expansion in this direction awaiting development at the hands of our domestic galvanoplastic operators.

The work above named is a practical handbook which will be found well adapted for the requirements of those interested in this branch of the arts. W.

The Recent Development of Physical Science. By William Cecil Dampier Whetham, M.A., F.R.S., Fellow of Trinity College, Cambridge. (8vo, pp. xii + 344.) Philadelphia: P. Blakiston's Son & Co. 1904. (Price, $2.00.)

In this work the author gives an exposition as free as possible from technical language of some of the most important investigations which are now being carried on in the leading physical laboratories of the world. Those embrace, for example, such topics as the liquefaction of gases and the absolute zero of temperature, fusion and solidification, the problems of solution, the conduction of electricity through gases, radio-activity, atoms and ether, astro-physics, etc.

Official Report upon the Mines, Mining, Metallurgy and Mining Laws, &c., &c., of the Argentine Republic, by H. D. Hoskold, M. and C.E., &c. Buenos Ayres, South America, Bank Note Co., 1904.

This is a well-printed, stiff-paper covered, royal octavo, book of 475 pages, by H. D. Hoskold, Inspector General of Mines of the Argentine Republic and Director of the Government Department of Mines and Geology. It is an unusually successful attempt at English book-making by Latin typos, though frequent instances occur of such errors as only journeymen foreign to the language they are setting up may be excused for making. Although its character is that of a classified list or description, it badly needs both a table of contents and an alphabetical index. The first chapter of 44 pages contains an interesting compilation of the various histories of the Incas, of Peru, and of the other parts composing Argentina.

The title of the second chapter, "Historical Sketch of Modern Mining," is misleading. What is meant is of more recent mining in Argentina. It takes 22 pages. The third chapter of 34 pages is concerned with the different economic minerals in the Province of La Rioja. This subject is treated very concisely. It might more properly be considered a general

description of various minerals and their usual composition. Localities are named very rarely and then almost invariably the statement is queried. For instance, under "Kupfernickel,' the text says it * * * "generally contains the following elements, which are extracted from Bristow's Mineralogy"(!). The tables of percentages from page 91 to the middle of page 95 are somewhat lessened in value from the omission of a statement as to the substances referred to by the percentage values, but tables 47 to 102 the substances referred to by the percentage values, but tables 47 to 102, inclusive, give the constituents, the percentages and the names of the minerals, but as there are frequently very discordant values from the same mines, it would have been better to make the descriptions still more specific.

Chapter IV deals with the mining Province of "La Rioja"; Chapter V with the Copper, Silver and Gold Mines of the Province of the Districts of Mejicana, Ofir, Amapallo and others. Chapter VI, Mines and Mining in the Province Catamarca. Chapter VII, the same in the Province Tucuman; Chapter VIII, Salta; Chapter IX, Jujuy; X, Mendoza; XI, San Juan; XII, San Luis; XIII, Cordoba; XIV, Buenos Ayres; XI, the National Territory of the Andes; XVI, ditto Miseionas; XVII, ditto Central Pampa; XVIII, ditto Neuquen; XIX, ditto Rio Negro; XX, ditto Chubut; XXI, ditto Santa Cruz; XXII, ditto Terre del Fuego; XXIII, Metallurgy in Argentina.

The following is a sketch of the processes for reducing copper ores in the old style furnaces, near Pelican, three leagues southeast of Fuerte del Andalgala. 1st. Calcination of the crude ore; 2. Reduction of a portion of the crude ore to regulus and calcination of the same; 3d. pulverization and calcination of half the regulus obtained from the first reduction; 4th. "*Refunditon*" of a portion of the calcined regulus with a part of that not calcined; 5th. Refining Operation. Under the head of Hydro-metallurgy it is stated that low-grade copper ores containing 1½ to 3 per cent. Cu exist all over the district, and the wish is expressed that some cheap process, such as the Clourdet, the Henderson, or the Statberg process might be employed. Chapter XXIV, The Mining Laws of Argentina. Chapter XXV, The Coal Deposits and Geology of the Republic.

In the list of names of those who had contributed to our knowledge of the geology of Argentina it was remarkable that that of Prof. W. B. Scott, of Princeton, was missed. Chapter XXVI, General Observations and Data. Appendix. Catalogue of the official collection of minerals of Argentina mines sent to the St. Louis Exhibition.

The work was originally ordered by the Republic of Argentina for distribution at the Paris World's Exhibition of 1889. Subsequently Dr. Wenceslao Escalante, Minister of Agriculture, Comemrce and Industry, ordered a new work in English for distribution at the St. Louis Exposition.

F.

Committee on Science and the Arts.

(Abstract of Proceedings of the Stated Meetings of Wednesday, April 5th, and May 3d, 1905.)

DR. EDWARD GOLDSMITH in the chair.

The following reports were adopted:

(No. 2335.) *Eastman Co.'s Perfection Fire Nozzle and Fire Hose Support.* Cyrus E. Robinson, Concord, N. H.

This invention, which is covered by several letters patent of the United States, to applicant, consists of a hose-rest and a nozzle attached to a section of hose to which is attached a Siamese connection permitting a supply of water under pressure through one or more hose lines.

The hose rest consists of an iron rod to which is attached an iron "U"-shaped rest for the hose and a similar rest for the nozzle, the latter having in the arms of the rest a spring snap for engaging the lugs of the nozzle in order that the nozzle be held in place. The second "U"-shaped rest is provided with a leather strap so that the hose can be securely strapped to the hose rest. Suitable iron handles connect the two hose rests adapted to be grasped by a fireman in directing the stream. Connected with the rod, by a swing joint, is a second rod, having at its end a three-way prong to prevent slipping on the pavement. This rod is in two pieces, held together by an extension sleeve to permit raising or lowering the hose rest.

The nozzle, or play pipe, consists of two pieces, made of aluminum, for the purpose of reducing the weight of the apparatus, the play pipe being of various sizes, up to three inches or more, if desired. The base of the play pipe contains a cylinder of thin metal concentric with the play pipe and about one-half the diameter of the pipe. The cylinder is held in place by two radial plates at right angles and extending from the inner cylinder to the shell of the play pipe. This arrangement has a decided effect on the stream from the nozzle, holding it together for a great distance from the nozzle and preventing spraying of the stream.

The investigating committee made a number of tests of this apparatus in connection with the High Pressure Pumping Service at Delaware Avenue and Race Streets, Philadelphia. The hose stream showed a very superior delivery of water, though the apparatus could be used only within a very limited radius from a fixed position.

In recognition of the value of the apparatus as a hose-rest for controlling fire streams at high pressures, as well as its value in play pipe service for delivering a solid stream for a considerable distance from the nozzle, the award of the Certificate of Merit is made to the inventor. (*Sub-Committee*, Charles A. Hexamer, Chairman; Wm. McDevitt.)

(No. 2340.) *Color Photographs.* Michael Miley and Henry Mackey Miley, Lexington, Va.

ABSTRACT: In this method of chromo-photography the results are obtained by an application of the principles of the three-color process. The subject is photographed on three separate plates with light filtered through color screens of red, green, and violet, respectively.

From these negatives, photo-prints are made on gelatine pigment paper, such as carbon tissue, the carbon pigment being replaced by pigments of the three primary colors—red, yellow and blue—and the gelatine then sensitized in the usual way by potassium bichromate.

The blue tissue is exposed under the red screen negative; the red tissue under the negative from the green screen, and the yellow tissue under that from the violet screen. The prints are then developed upon celluloid supports by washing out with warm water, as usual.

The resulting pictures are transparent positives in the respective colors, the transparency and depth of color resulting from the graduation in thickness of the developed film of gelatine;; this variation in turn representing the graduations of light and shade of the respective negatives.

These colored diapositives are then transferred from the celluloid supports upon which they have been developed and superposed in proper registry on a suitable piece of gelatine coated with paper, which proves the final support. The red is usually transferred first, the yellow following over the red, and the blue over both, though in some cases the yellow is preferably made to underlie the red. Each film, before the succeeding one is imposed upon it, is followed with a solution of gelatine containing a hardening agent, such as chrome alum. The three films are then securely held together upon their support of white paper and by their combination of the three primary colors in graduations corresponding to those of the respective screen negatives, they present a reproduction of the color effect of the original.

Previous practice in this art in respect, especially, of the use of chemically inert pigments to impart the requisite color to the respective gelatine tissues has been essentially similar to the Miley procedure.

Another method in vogue involves the impregnation of the gelatine tissue with soluble tinctures of the requisite color, such as indigo or eosine, which are retained in the exposed and developed chrome-gelatine film in proportion as it has been rendered insoluble by the action of light.

Another method is to dye the three diapositives with tinctures which are absorbed by the gelatine in proportions corresponding to the carying thickness of the films as left by the development.

Another modification is to produce the first color picture directly on the paper by printing and toning, usually, in blue, and then using only the red and yellow diapositives in superposition on the blue print.

The report sets forth that the distinctive feature of the Miley process consists in the method of imparting the requisite color to the respective tissues of gelatine, which he effects by the use of finely-ground pigments of red, yellow and blue, of a spectroscopic color value equal to, or approximating, the color value of the corresponding primary in the original subject. These are incorporated with the gelatine solution by intimate mixture, substantially in the manner in which carbon is incorporated with the gelatine solution in making tissue for carbon prints; the prime requisite in both cases being that the pigment should be inert—chemically—as regards both the gelatine and the chromic sensitizer. The novelty of the Miley process

appears, from the report, to consist in the method of developing the prints, and transferring them, after development, to their permanent support.

The report concludes with the statement that the details of the process have been thoroughly worked out and fully described in the patent specification. (See U. S. Patent, No. 711,875, October 21st, 1902.)

In view of the excellent results of which this process is capable—as evidenced by the specimens submitted for examination, the award of the Edward Longstreth Medal of Merit is made to the inventors. (*Sub-Committee*, Louis E. Levy, Chairman; Samuel Sartain, Daniel Baker.)

(No. 2352.) *The Phonosphere.* The Phonosphere Mfg. Co., New York.

ABSTRACT: This invention, which is the subject of U. S. letetrs patent Nos. 685,024, Oct. 22, 1901; 692,409, Feb'y 4, 1902; and 717,311, Dec. 30, 1902, to John E. Alexander, is an improved form of talking machine and record blanks for the same. The record blank consists of a spherical disk (*i. e.*, one in which the record surface is part of the convex surface of a sphere) of 10 inch radius, the limiting boundary of the surface being a circle.

The disk is mounted at one end of a shaft, which is rotated by means of a friction wheel, the edge of which works upon a second spherical driving disk concentric with the record disk. The mechanical arrangement is such that the shaft supporting and rotating the record disk is gradually brought from an inclined to a vertical position, thus enabling a stationary stylus to engrave a continuous record in a spiral path, passing from the periphery towards the center. This spiral is again traced in transmitting the record thus produced.

The report comments as follows upon this combination: The form of the record tends to secure freedom from warping and gives a large superficial area for reproduction. This large area permits a high rate of speed of rotation, thus increasing the amplitude of the vibrations, and, consequently, the volume of the sound. The mechanism secures a uniform length at all parts of the record for the same time.

The stylus arm is stationary and the requisite pressure upon the stylus is light, thus tending to reduce the wearing upon both stylus and record.

These improvements are recognized by the award to the inventor of the Edward Longstreth Medal of Merit. (*Sub-Committee*, Geo. A. Hoadley, Chairman; Wm. O. Griggs, T. Carpenter Smith, Thomas Spencer. Chairman; Wm. O. Griggs, T. Carpenter Smith, Thomas Spencer, L. F. Rondinella.

(No. 2355.) *Metallic Railway Tie.* Richard Raby, York, Pa. (An advisory report.)

(No. 2358.) *Colt Automatic Pistol.* The Colt's Patent Firearms Mfg. Co., Hartford, Conn.

ABSTRACT: This invention is the subject of the following letters patent of the United States, Nos. 580,924,5,6, April 20, 1897; 708,794, Sept. 2, 1902, and 747,585, Dec. 22, 1903, granted to John M. Browning, of Ogden, Utah, and is manufactured by the applicant.

In its fundamental features of design, the Colt Automatic Pistol closely resembles the modern magazine military rifle. The breech block consists of a bolt sliding parallel to the axis of the barrel. The cartridges are

spring-fed through a suitable opening underneath the frame and are pushed into place by the closing of the breech. The empty shell is ejected in substantially the same manner and by devices now long in use in self-ejecting rifles, by the rearward movement of the block. After the first cartridge has been fired, the breech automatically opens by the reaction of the firing impulse, ejects the empty shell and closes by the pressure of a reaction spring, inserting a fresh cartridge ready for firing at the will of the operator. The latter feature is provided for by a device that prevents the release of the hammer until the trigger is freed and again pulled. Without this device, it is noted in the report, the action would become automatic, uncontrollable and far too rapid.

An elaborate mechanical description of the invention follows, which would be unintelligible without the aid of illustrations. The report concludes as follows: "The conclusion of the sub-committee is, on the one hand, that the inventor has devised a safe, powerful and serviceable arm of simple design, and on the other, that the manufacturers, in the commercial production of an arm whose component parts are radically different from those of the same class previously manufactured, have displayed commendable skill in manufacturing engineering."

The report, in conclusion, recommends the award of the John Scott Legacy Premium and Medal to John M. Browning, the inventor, and of the Edward Longstreth Medal of Merit to the Colts' Patent Fire Arms Mfg. Co. (*Sub-Committee*, Lucien Picolet, Chairman; J. M. Emanuel, Wm. O. Griggs, W. J. Williams, F. Lynwood Garrison.)

The following reports passed first reading:

(No. 2213.) *The Hill Torch and Tracer.* John B. Semple, Pittsburgh, Pa.

(No. 2216.) *The Nernst Lamp.* The Nernst Lamp Co., Pittsburgh, Pa.

(No. 2338.) *Electrolytic Interrupter for Induction Coils.* Dr. A. Wehnelt, Charlottenburg, Berlin, Germany.

(No. 2357.) *Photo-Printing Machine.* L. F. Rondinella, Philadelphia.

WM. H. WAHL,
Secretary.

Sections.

MINING AND METALLURGICAL SECTION. *Stated Meeting*, held Thursday, February 2d, 8 P.M., Mr. G. H. Clamer in the chair. Present, 45 members and visitors.

The following officers were elected to serve for the year 1905: President, Mr. G. H. Clamer; Vice-Presidents, Prof. A. E. Outerbridge, Jr., and Mr. James Christie; Secretary, Dr. Geo. P. Scholl; Conservator, Dr. W. H. Wahl.

The President introduced the speaker of the evening, Dr. Richard Moldenke, Secretary to the American Foundrymen's Association, who read a paper on "The Testing of Cast Iron." The paper called forth a lengthy discussion, participated in by Messrs. Paul Kreuzpointner, Altoona, Pa.; G. H. Clamer, H. S. Haldeman, Arthur Falkenau and several visitors. The paper, with discussion, will appear in the *Journal* in due course.

The Chairman expressed the thanks of the meeting to those who had participated in the evening's event, and the session was adjourned.

WM. H. WAHL,
Secretary pro tem.

Stated meeting, held Thursday, March 9, 8 P.M. Mr. G. H. Calmer in the chair. Present, 27 members and visitors.

The President introduced Mr. Spurr, of the U. S. Geological Survey, Washington, D. C., who read a paper describing the geological and topographical features of the Tonopah Mining District in Western Nevada. The speaker illustrated his remarks with the aid of a number of lantern slides. The subject was discussed by the chairman, Dr. H. Chance, Dr. E. Goldsmith and the author. A vote of thanks was extended to Mr. Spurr for his admirable communication.

In the absence of the author, a paper by Dr. N. S. Keith on "New Methods in the Metallurgical Treatment of Copper Ores," was read by the Secretary. A brief discussion followed.

Both papers are referred to the Committee on Publications.

GEORGE P. SCHOLL, *Secretary.*

Stated meeting, held Thursday, April 20th, 8 P.M. Mr. G. H. Clamer, President, in the chair.

Present, 14 members and visitors.

The paper of the evening was read by Dr. George P. Scholl, on "Modern Improvements and Tendencies in the Metallurgy of Gold." Some discussion followed and the meeting was adjourned.

G. P. SCHOLL, *Secretary.*

MECHANICAL AND ENGINEERING SECTION. Stated Meeting, held Thursday, April 13, 8 P.M., Mr. John C. Trautwine, Jr., in the chair.

Present, 38 members and visitors.

The chairman introduced Mr. Kenneth Allen, Superintendent of the Water Department of Atlantic City, N. J., who read a carefully-prepared paper on "The Sanitary Protection of Public Water Supplies." The paper was freely discussed by the chairman, Drs. Henry Leffmann and W. J. Williams, and the author.

The chairman extended the thanks of the meeting to the speaker of the evening and announced the session adjourned.

WM. H. WAHL,
Secretary pro tem.

Stated meeting, held Thursday, April 27, 8 P.M. President Charles Day in the chair.

Present, 126 members and visitors.

The meeting was devoted to the discussion of the subject of Internal Combustion Engines. The discussion was opened by Prof. H. W. Spangler, who was followed by other speakers in the order given: Mr. John E. Codman, Philadelphia Bureau of Water; Mr. L. B. Goebbels, Otto Gas

Engine Co.; Mr. John D. MacPherson, American Diesel Engine Co.; Mr. John R. Bivins, Westinghouse Engine Co. The President likewise contributed to the discussion.

On account of the lateness of the hour, the further consideration of the subject was deferred until the next stated meeting. Adjourned.

WM. H. WAHL,
Secretary pro tem.

ELECTRICAL SECTION. *Stated Meeting*, held Thursday, February 9, 1905. Mr. Thomas Spencer in the chair.

The paper of the evening was read by Mr. Washington Devereux, Electrical Engineer to the Philadelphia Fire Underwriters' Association, on the subject of "The Inspection of Electric Conductors, with Especial Reference to Fire Protection."

The speaker illustrated his theme by the exhibition of numerous lantern slides, models, etc., which strikingly demonstrated the dangers of faulty practice.

An informal discussion followed, which was freely participated in by the members and visitors present.

The President thanked those who had contributed to the proceedings of a highly interesting meeting, and adjourned the session.

RICHARD L. BINDER,
Secretary.

A stated meeting of the Electrical Section was held on Thursday, March 30, 8 P.M., President Thos. Spencer in the chair.

The minutes of the last meeting were read and approved.

The paper of the evening was then read by Mr. E. H. Rushmore, of the Stanley Electrical Mfg. Co., Pittsfield, Mass., on "The Design and Manufacture of Alternating Current Generators."

Mr. Rushmore showed the great care and great amount of detail which must be taken care of in the manufacture of up-to-date apparatus and the accuracy to which the engineering problems, in designing machinery of this type, have attained.

There were seventy members and visitors present. A vote of thanks was accorded to Mr. Rushmore. There being no further business the meeting adjourned.

RICHARD L. BINDER,
Secretary.

SECTION OF PHOTOGRAPHY AND MICROSCOPY.—The 31st stated meeting of this Section was held on Thursday, February 23d, at 8 o'clock. Dr. Henry Leffmann in the chair. Present, 32 members and visitors.

Dr. Leffmann gave an informal description of certain "New Forms of Stereoscope, Spectroscope and Microscope, and New Applications Thereof."

In the course of his remarks, Dr. Leffman called attention to several

improved forms of projecting apparatus, called the "Epidoscope," and the "Epidiascope," made by Carl Zeiss, of Jena, and showed sectional views of these devices on the screen.

Mr. Urbane C. Wanner exhibited a number of interesting photographic prints, and commented on them.

Following this communication there was an exhibition of lantern slides by Mr. J. H. Fenton and Mr. D. W. Ridpath. Adjourned.

M. I. WILBERT, *Secretary.*

The thirty-second meeting of the Section was held on Thursday, April 6th, at 8 P.M., Dr. Henry Leffmann in the chair.

Present, 42 members and visitors.

After the transaction of the regular business program, Dr. Leffmann and Mr. Hugo Bilgram exhibited and commented on a number of microscopic subjects—rocks and crystal sections, insects, etc.—which were shown on the screen by means of the projecting microscope. This was followed by a description of the construction, and a demonstration of the method of operating the "Graflex" camera by a representative of the manufacturers.

The remainder of the session was devoted to the exhibition of a number of lantern photographs representing scenes and landmarks in Lancaster county, Penna. These slides were loaned for the purpose by Mr. Webb, and were shown and commented upon by Dr. Leffmann.

The chairman thereupon adjourned the meeting.

MARTIN I. WILBERT,
Secretary.

V.1
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The 33d stated meeting, held Thursday, May 4, 8 P.M. Dr. Henry Leffmann in the chair.

Present, 27 members and visitors.

The first communication of the evening was made by Mr. Howard W. DuBois, Mining Engineer, Philadelphia, on "A Simple Camera for Photographic Surveying," and incidentally, on "The Use of Hydrogen Peroxide as a Photographic Agent."

In connection with these subjects, Mr. DuBois showed a number of lantern photographs, illustrating various methods and camera constructions used for photographic surveying. Also a number of pictures, showing the reversal of the photographic image by prolonged exposure.

The subject was discussed by Dr. H. E. Wetherill, Dr. E. Goldsmith, the chairman and the author.

Dr. W. J. Williams, Chemist to the Frankford Arsenal, exhibited and gave a demonstration with some photographic flash powders of his invention.

Dr. Leffman followed with some remarks on the work of Dr. August Köhler, of Jena, Germany, in the use of ultra-violet light in photographs, and referred to the practical results obtained with apparatus made for the purpose by Carl Zeiss Co., of Jena. Adjourned.

M. I. WILBERT,
Secretary.

CHEMICAL SECTION.—Stated Meeting, held Thursday, March 23d, 8 P.M. Dr. E. Goldsmith in the chair.

Present, 32 members and visitors.

The paper of the evening was read by Mr. Richard L. Humphrey, on "The Manufacture of Portland Cement," in the course of which the speaker gave a historical sketch of this important industry, with especial reference to its development in the United States.

The subject was freely discussed, and at the close of the session a vote of thanks was passed to the speaker of the evening.

The Secretary reported the result of the ballot on the question of uniting the Physical and Chemical Sections. It was thereupon decided that the Committee on Sectional Arrangements be requested to authorize the union of the two Sections under the name of Section of Physics and Chemistry. Adjourned.

WM. H. WAHL,
Secretary pro tem.

SECTION OF PHYSICS AND CHEMISTRY.—Stated meeting, held Thursday, May 11, 8 P.M. Dr. Edward Goldsmith in the chair.

Present, 32 members and visitors.

The chairman introduced Dr. G. H. Meeker, Medico-Chirurgical College, Philadelphia, who exhibited and described a number of new forms of apparatus and methods in clenical chemistry. These included, a so-called micro-burette, come improvements in centrifugal apparatus; apparatus for the estimation of urea; a novel end reaction of the hypobromide test for urea; a so-called albumoscope; an apparatus for determining the percentage of fat in milk; an improved method of determining the alkalinity of blood; an improved analytical balance to permit of the weighing of bulky objects, and several minor devices and methods.

Discussed by Drs. H. F. Keller, W. J. Williams and the author.

The subject of Dr. Meeker's invention was referred to the Committee on Science and the Arts.

Dr. Henry Emerson Wetherill, of Philadelphia, followed with an exhibition and description of a number of new Diagnostic Instruments of his invention, including a new colorimetric scale in testing for for hæmoglobin, humidity of the skin, &c., several improved centrifugal machines for clinical and other uses, on the principle of the whirligig; an improved stethoscope, and other minor devices.

The Section passed a vote of thanks to the speakers of the evening.

The Secretary reported that a Board of Managers had approved the report of the Committee on Sectional Arrangements, recommending the consolidation of the Physical and Chemical Sections, under the title of the Section of Physics and Chemistry.

Adjourned.

WM. H. WAHL,
Secretary pro tem.

Franklin Institute.

(Proceedings of the Stated Meeting held Wednesday, April 19, 1905.)

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, APRIL 19, 1905.

PRESIDENT JOHN BIRKINBINE in the chair.

Present, 48 members and visitors.

Additions to membership since last report, 6.

The President introduced Mr. George S. Webster, Chief Engineer of the Bureau of Surveys, Department of Public Works, Philadelphia, who presented a carefully prepared paper on "The Improvement of the Delaware River and Harbor and the Landing Facilities of the Port of Philadelphia."

The paper was profusely illustrated with the aid of lantern photographs, and was freely discussed. The chairman extended the thanks of the meeting to the speaker of the evening, and announced the session adjourned.

WM. H. WAHL,
Secretary.

Proceedings of the Stated Meeting held Wednesday, May 17th, 1905.

HALL OF THE INSTITUTE,
PHILADELPHIA, MAY 17th, 1905.

VICE-PRESIDENT WASHINGTON JONES in the chair.

Present, 64 members and visitors.

Additions to membership since last report 8.

Prof. F. L. Garrison presented the first communication of the evening, giving his "Observations on the Geology and Mineral Resources of San Domingo." The speaker illustrated his remarks with the aid of a number of lantern photographs of views taken by himself during a recent professional trip through the Island. The subject was discussed by Dr. Edward Goldsmith and the author.

Prof. Lewis M. Haupt followed with some "Comments on the American International Ship Canal," in which he considered the comparative merits of the Panama and Nicaragua routes, illustrating his remarks with a series of lantern views. Prof. Garrison and the speaker discussed the subject.

The chairman extended the thanks of the meeting to the speakers of the evening and adjourned the meeting.

WM. H. WAHL,
Secretary.